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ABSTRACT

Presented is a detailed study of National Science Foundation (NSF) programs in pre-college science education. The development of policies and operational procedures are traced over the past quarter century and their impact on management practice analyzed. The report is presented in two parts: Volume 1, the findings and recommendations, and Volume 2, the basic documents related to Volume 1. This Volume (Volume 2) contains seven appendices as outlined: Appendix 1, the letters and memorandum establishing purpose and charge to the Review Team; Appendix 2, an historical overview of program growth and the factors that had impact on NSF policies and programs; Appendix 3, an analysis and background of distribution policy and financial arrangements; Appendix 4, five summary case studies developed as an aid in staff and Review Team development of observations and policy issues presented in Volume 1; Appendix 5, the summary audit prepared by the NSF Audit Office of the five projects selected for case study; Appendix 6, two commissioned papers which present some other views on support of curriculum development and implementation; and Appendix 7, a table summarizing project funding, developer, publisher, and royalty arrangements. (Author/CS)

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Pre-College Science Curriculum Activities of the National Science Foundation

REPORT OF
SCIENCE CURRICULUM REVIEW TEAM

MAY 1975

Volume II—Appendix

SE 022 383

FOREWORD

Volume II—Appendix of The Report of the Science Curriculum Review Team on Pre-College Science Curriculum Activities of the National Science Foundation includes many of the basic documents used to arrive at the findings and recommendations contained in Volume I. These are supported in many instances with substantial additional documentation too voluminous to publish.

Included as Appendix 1 are the letters and memorandum establishing the purpose of and charge to the Review Team.

Appendix 2 contains an historical overview of program growth and the factors that impacted on NSF policies and programs, including a description of Congressional interest, National Science Board involvement, and the current approach to pre-college science education reflecting the influence of the Executive Office of the President.

Appendix 3 provides an analysis and background of distribution policy and financial arrangements. It also includes a summary of oversight procedures.

Appendix 4 contains the five summary case studies developed as an aid in staff and Review Team development of the observations and policy issues presented in Volume I. Synopses of these cases can be found in Section II of Volume I.

Appendix 5 is the summary audit prepared by the NSF Audit Office of the five projects selected for case study.

Appendix 6 contains two commissioned papers which present some other views on support of curriculum development and implementation.

Appendix 7 is a table summarizing project funding, developer, publisher, and royalty arrangements.

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Appendix 1

Charge to the Review Team

1. Letter from the Director, NSF to Congressman Olin Teague, March 17, 1975.
2. Letter from the Director, NSF to Congressman Olin Teague, April 1, 1975.
3. Letter from the Director, NSF to Dr. Joel A. Snow, Director, Office of Planning and Resources Management, April 2, 1975.
4. Memo from the Director, NSF to Chairman, Science Curriculum Review Team, April 17, 1975.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICE OF THE
DIRECTOR

March 17, 1975

Honorable Olin E. Teague
Chairman
Committee on Science and Technology
House of Representatives
Washington, D. C. 20515

Dear Chairman Teague:

I have now had a chance to talk about MACOS with a number of members and staff of the Committee on Science and Technology and especially of the Subcommittee on Science, now that all have had a full opportunity to see all of the MACOS material--films, teacher manuals, student pamhplets, etc. The top leaders of the NSF staff, including the Director, Assistant Directors, and members of both the Executive and Management Councils and others have also examined the material.

Because of the concerns expressed on all sides of several issues, I have decided that, regardless of what action is taken by Congress, no further 1975 funds will be obligated for MACOS, and no 1976 funds, if authorized and appropriated, will be obligated either for MACOS or any other precollege science course development and implementation until we have conducted a thorough review of the NSF effort in these areas and reported to the National Science Board and Congress with recommendations. I will assign a top-level group of staff from the Foundation with some members outside the Education Directorate, together with some carefully chosen outsiders to make this report to me.

I have also considered the possibility of recalling the MACOS portion of the implementation grants made in January and announced publicly on January 15, 1975, before any of the current discussion on MACOS was brought to my attention. Personally, I do not believe that this can be done without opening the door to counter protests and claims of censorship. I will discuss this with the National Science Board during their meeting on March 20 and 21 after which time I will determine whether or not this can or should be done.

As background to the following examination of MACOS issues, I would like to point out that there should be no surprise on anyone's part that NSF is in this kind of precollege (elementary and secondary school) science course development and implementation. MACOS is one of 38 courses developed since 1956 in physics, mathematics, chemistry, biology, anthropology, geography, sociology, engineering, general science, political science and others. Some of these are greatly successful and very well known in and out of education circles. Others are only in their early implementation stages. Furthermore, there are an additional 12 courses, still under development, in biology, mathematics, interdisciplinary science, psychology, algebra and other fields, which have been started in the period from 1968 to 1974.

The Congress, responding to recommendations from different segments of the educational and scientific communities, has long encouraged us in this kind of science education venture.

The controversy over MACOS has several different focal points which I believe can be summarized by the following questions:

1. Is the scientific material truthful and factual?

2. Is it a proper collection of material for fifth and sixth graders?

3. Who should decide that question?

4. Do teachers carry the class discussion far afield from the content of the recommended material?

5. Has the NSF followed proper contracting procedures in the development and implementation of MACOS?

6. Does the NSF go too far in implementation of precollege science education courses?

7. What evaluation procedures are proper for MACOS and similar courses?

8. Has NSF had a broad enough examination of the total coverage of its precollege science course developments?

I would like to speak briefly to each of these questions, although clearly each deserves a very long treatment.

1. Is the scientific material truthful and factual?

From my examination of the material and from conversations with experts in the education and anthropology field, I believe that there is general agreement that the scientific material on which the course is based is accurate. Any action Congress or NSF or anyone else might take based on this point would produce a large flow of positive opinion about the accuracy of the course content of MACOS.

2. Is it a proper collection of material for fifth and sixth graders?

There is a sharp difference of opinion of this point. Some believe that parts of the material are too gory. Hardly anyone believes that there are not gory parts in some films, but the difference of opinion comes in attitude about when such material should be exposed to students. Some believe that sex is over done; others are on the opposite side. Some believe that the material in toto reinforces strong family traditions; others feel just the opposite. There are similar disagreements on other topics such as crime, communal living, etc., which generate strong emotions. In this area, value judgments are sharply held.

3. Who should decide that question?

We cannot say categorically that all fifth and sixth graders should see this material or that none should. There clearly are strongly held opinions amongst scientists, educators and many others that this is a proper and very desirable course for that age group. There is clearly opposition to this opinion.

An important practical matter as far as this material is concerned is that this course is widely available. The decisions as to whether or not it should be taught or whether it should be elective or required are now out of the hands of the NSF and the Congress. These decisions are being made by local school systems, and I believe that this is the proper decision point.

In treating questions 2 and 3, I have considered the suggestion that the NSF contact every school board to inform them that the course has generated controversy and that we urge each school board to have a very thorough examination by public officials, teachers, parents and all others of the community, working together, before deciding upon use. I will discuss this possible action with the National Science Board on March 20 and 21. Clearly, there are pros and contras to such action.

4. Do teachers carry the class discussions far afield from the content of the recommended material?

We believe that this is entirely a matter for local judgment.

5. Has the NSF followed proper contracting procedures in the development and implementation of MACOS?

What I have learned to date on this point indicates a positive answer. We will of course continue to pursue our investigations of this point.

6. Does the NSF go too far in implementation of precollege science education courses?

We have responsibility to respond to positive needs for help in implementation. However, as mentioned earlier our implementation will be reexamined by the National Science Foundation.

7. What evaluation procedures are proper for MACOS and similar courses?

We have had evaluation during the course development and implementation. Now we are proceeding more to independent evaluators of courses after they have gone into school systems. We at NSF will be doing much more work along this line in the future.

8. Has NSF had a broad enough examination of the total coverage of its precollege science course developments?

This is another question which must be discussed within the Foundation with recommendations made to the National Science Board and other interested parties concerning the future of this activity.

I hope that further attention by the National Science Foundation staff and the National Science Board will bring this broad activity under oversight which is satisfactory to the Congress.

Sincerely yours,

H. Guyford Stever
Director

Copy to: Congressman James W. Symington
Congressman Charles A. Mosher

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICE OF THE
DIRECTOR

April 1, 1975

Honorable Olin E. Teague
Chairman
Committee on Science and Technology
House of Representatives
Washington, D. C. 20515

Dear Chairman Teague:

At the National Science Board meeting on March 20 and 21, I had the opportunity to brief the Board on the recent events related to the curriculum project "Man: A Course Study" (MACOS) and the current discussions surrounding it and the general question of course implementation. We carefully reviewed in detail the points made in my previous letters to you and Mr. Conlan on the subject. As I indicated in my letter of March 17, I asked the Board to consider several questions that were unresolved.

In this discussion, the role of the NSF in science course development was reexamined. The Board continues to believe that the NSF role is that of selecting science course development projects which are believed to have significant promise of strengthening science education. In that selection NSF must ensure that:

- the proposed subject matter fits within reasonable limits or norms with respect to educational value;
- the scientific content is accurate;
- the course developers are responsible and competent persons;
- the institutional and contractual arrangements are sound.

The Board concurs with me that it is not the perogative of the NSF to dictate what course material should be taught in primary and secondary schools or in the colleges and universities. That is for the appropriate local authorites to decide. That has always been our position.

In implementation of courses, the Board agrees that NSF has a responsibility to help science teachers at all levels become acquainted with a variety of material. Our implementation efforts should not be solely concerned with NSF-funded course developments but should include a variety of good science courses wherever developed.

As has been our policy, the Board reaffirms that no material may be marketed with any NSF endoresement and that printed material should contain an express disclaimer.

The National Science Board unanimously approved the action for a study by the NSF, as I outlined in my letter to you. My suspension of further obligations of FY 1975 funds for MACOS implementation and of all precollege development and implementation grants in FY 1976 will not seriously affect this field provided that the study is completed by June as scheduled and, of course, provided the decision resulting from the study is to continue the program.

The Board, after consideration of all facets of the question, has agreed unanimously with my recommendation not to rescind the implementation grants that were awarded in January. These grants were made in good faith, they cover a variety of courses, not just NSF-funded course developments, and only a small portion of these have any MACOS content. Their continuation will in no way bias the longer term examination of the NSF course implementation policies and procedures. At my request, the Board also considered the possibility of sending a precautionary note to every school district in the country. This was rejected as being both an unnecessary and a gratuitous intrusion into the local decision-making process.

The Pre-college Education in Science Program has recently been reviewed by the Board. Nonetheless, the Board in endorsing the plan for the internal Foundation study, will participate in a deeper review through the appointment of a Board Member to work with the top-level NSF staff assigned by me to this review. Following this Board consideration, I will report to your Committee.

In my NSF review I plan to have investigated the pre-college curriculum development activities in a broad sense, including MACOS particularly and also the program more generally. To do this, some procedural questions will be studied; for example, the distribution rights and royalty arrangements. In addition to a general survey of all of the curricula that have been developed, I shall have the review team make a detailed study of several cases as well as MACOS to see what they illustrate about the procedures that NSF has used in the support of curriculum development. The review will examine the following:

(A) Curriculum Development Program

(1) History

(2) Case Studies

a. Chemistry curriculum, 1959-1969
b. Science Curriculum Improvement Study, 1962-Present
c. Man: A Course of Study, 1963-1970
d. Comparing Political Experiences, 1972-Present
e. Individualized Science Instructional System, 1972-Present

(B) NSF Distribution Policy and Royalty Arrangements

(1) History
(2) National Science Board Policy (1969)

(C) Curriculum Implementation Procedures

(1) History
(2) Research Studies Regarding Implementation
(3) Current Practices

(D) Evaluation Procedures for Establishing Content and Utilization

(E) Practices and Procedures in Science Curriculum Developed by Other Organizations

(F) Recommendations

Although we are still assembling the review team, our intent is that it will be comprised of at least the following:

Dr. Robert E. Hughes, Assistant Director for National and International Programs (Chairman of the Review Team)

Dr. Grover E. Murray, Member, National Science Board, and President, Texas Tech University and Texas Tech University School of Medicine

Dr. L. Donald Shields, Member, National Science Board, and President, California State University at Fullerton

Mr. Robert B. Boyden, Audit Officer

Dr. Eloise E. Clark, Director, Division of Biological and Medical Sciences

Dr. James D. Cowhig, Deputy Director for Public Sector Productivity

Mr. Walter M. Hudson, Budget Officer

Dr. J. Arthur Jones, Program Analyst, Office of Planning and Resources Management

Mrs. Maryann B. Lloyd, Deputy General Counsel

Mr. Leonard A. Redecke, Contracts Administrator

Dr. Joel A. Snow, Director, Office of Planning and Resources
Management (Executive Secretary of Review Team)

The team will make its report to me on May 14. The National Science Board will review the findings at its meeting on May 15 and 16, and I shall report to you after that review.

In order to get outside opinion as well, I will ask our Advisory Committee on Science Education to consider and advise on the report of this internal group in a draft stage. The Advisory Committee is composed of the following:

Dr. M. Ann Grooms, Chairperson
President, Educational Services Institute, Inc.
Cincinnati, Ohio

Dr. Richard D. Anderson
Department of Mathematics
Louisiana State University

Dr. J. Myron Atkin
Dean of Education
University of Illinois

Dr. Ernest A. Boykins, Jr.
President, Mississippi Valley State College

Mr. John Burnett, undergraduate student
Oregon State University

Dr. Susan Goldhor
Dean, School of Natural Science
Hampshire College, Amherst, Massachusetts

Dr. Robert Karplus
Lawrence Hall of Science
University of California at Berkeley

Dr. Bernard Luskin
Vice Chancellor - Educational Development
Coast Community College District
Costa Mesa, California

Dr. Michael Scriven
Professor of Philosophy
University of California at Berkeley

Dr. John G. Truxal
Dean of Engineering
State University of New York at Stony Brook

Dr. Carl M. York, Jr.
Denver, Colorado

I trust that the plans for the internal review of the pre-college curriculum development and implementation demonstrates our intent to provide sufficient additional oversight and review to the pre-college curriculum programs.

Sincerely yours,

H. Guyford Stever
Director

Copy to:
Representative James W. Symington
Representative Charles A. Mosher

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

OFFICE OF THE
DIRECTOR

April 2, 1975

Dr. Joel A. Snow
Director, Office of Planning
and Resources Management
National Science Foundation
Washington, D.C. 20550

Dear Joel:

As you know, the authorization and appropriation hearings on the FY 1976 budget, the posture hearings, and other recent interactions with the Congress have brought to the fore a number of Foundation programs and procedures over which there is deep Congressional concern. Among these, the one viewed in the Congress and by the National Science Board as deserving immediate attention is the concern over policies guiding the Pre-college Education in Science Program. In order to review thoroughly the Foundation's activities in this area, I am appointing an ad hoc study committee that will be headed by Assistant Director Robert E. Hughes. Because of your professional background and your position in the Foundation management, I am designating you a member of the study team. The other members of the team and the general scope of the work for the review is outlined in the letter to Congressman Olin E. Teague which is enclosed.

The general schedule for the study team's work is as follows:

April 3-4	Organization of committee by Dr. Snow, the Executive Secretary.
April 7	First meeting with Dr. Hughes, development of detailed work schedule for month of April.
May 1	Completion of first draft of report and recommendations.
May 4-5	Meeting between the *ad hoc* study committee and the Advisory Committee on Science Education.
May 13	Submission of final report to NSF Director.
May 15	NSF Director reports to NSB.
May 19	NSF Director reports to Committee on Science and Technology.

The organization meeting of the study team will be held on April 3 between 2 and 4 p.m.

I know that you and the other members of the review team all have very heavy schedules. I am asking you, however, to have your normal work handled by other people in your office to the extent that is necessary to have a thorough review of the pre-college curriculum activities. There is no issue before the Foundation at the moment of greater importance, and I am confident that you will give this the attention that is required.

Sincerely yours,

H. Guyford Stever
Director

Enclosure

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Chairman, Science Curriculum Review Committee **DATE:** April 17, 1975

FROM : The Director

SUBJECT: Scope and Charge for the Committee

REF : My Letter of April 2, 1975 and Attachment

I am pleased to learn that the initial organization of the study of our curriculum development procedures is well underway and that your group is moving forward at its tasks. I know that you are well aware of the importance I attach to this undertaking and the value it should have in improving our approach to this and other areas of Foundation management practice. Let me reinforce certain issues which must be clearly addressed. I expect that your committee will thoughtfully assess whether, in these programs, our procedures ensure that:

- the proposed subject matter fits within reasonable limits or norms with respect to educational value;
- the scientific content is accurate;
- the course developers are responsible and competent persons;
- the institutional and contractual arrangements are sound.

The expanded outline (attached) for study which you have submitted to me, is approved. I am in general accord with the way you are proceeding. However, I want to stress several further points to keep in mind. You must ensure that:

___ the study and analysis is in all respects independent and objective,

___ the examination of cases and experience is complete and unbiased by our previous practices,

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__ the scrutiny of our fiscal and management approach is thorough and unhindered by past commitments,

__ potential or real conflicts of interest are carefully addressed,

__ NSF policies and practices are carefully scrutinized to ensure that the appropriate role of NSF in curriculum development is being followed.

In the process of fulfilling this responsibility you must ensure that:

__ a thorough examination of past practices is undertaken

__ a rigorous analysis of business and contractors relationships is developed, and

__ positive recommendations for improving the program's practices are developed.

A fully effective analysis of these issues is essential to honest examination of the integrity of our curriculum programs.

As you know, I am committed to reporting our conclusions to the Congress after appropriate discussion with the Advisory Committee for Science Education and the National Science Board. Your work is a crucial element in formulating this report. Let me urge you to require that in every respect that this study will be a model of objective and professional analysis.

I urge you to make the full use of Foundation staff and the scientific community in carrying out this analysis. My remarks to you and the staff involved in this study at your first meeting indicate how important I feel this study is to the NSF. There is no issue before us of greater importance and I am confident that you will give it the attention that is needed.

H. Guyford Stever

Attachment

Appendix 2

Overview of the Pre-College Science Education Programs

1. History of NSF Involvement in Pre-College Science Education
    - A. The Early Years
    - B. Curriculum Development
    - C. Curriculum Implementation
2. National Science Board Involvement
3. Legislative Oversight
4. Overview of Present Practice
    - A. Introduction
    - B. Materials and Instructional Development
    - C. Instructional Improvement Implementation Practices
    - D. Summary

History of NSF Involvement in Pre-College Science Education

In *Science, The Endless Frontier*, which provided the rationale leading to the establishment of the National Science Foundation, Vannevar Bush and his advisory committees indicated a concern for (1) broadening the base from which students with scientific aptitude and talents could be drawn, and (2) filling the wartime deficit of scientists and engineers. The problem of teaching did not go unnoticed and the report stated:

> Improvement in the teaching of science is imperative, for students of latent scientific ability are particularly vulnerable to high school teaching which fails to interest or provide adequate instruction.

The National Science Foundation Act of 1950 authorized and directed the NSF along with other functions, "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." It stated that it shall be one of the objectives of the NSF to strengthen basic research and education in the sciences.

The Early Years

NSF's initial response to its mandate to support the promotion of basic research and education in the sciences was in the form of fellowships for graduate education in the sciences. During the first years NSF effort in science education focused on the training of graduate students; although there were some evident concerns as to the quality of faculty at the undergraduate level. Other activities through which the Foundation could make major contributions to strengthen science education were studied.

NSF had recognized that one of its primary responsibilities in achieving scientific progress was the training of scientific manpower. While the problem of scientific manpower was to be resolved in the short term through graduate fellowships, improvement of the quality of science instruction in the schools would take place through a program for individual science teachers to spend summers at research centers or special seminars, and by the establishment of institutes for summer research. This effort evolved into the Institute program.

Early justification for science education programs centered on perceived critical shortages of scientific and engineering personnel and indications that such shortages would continue for at least a decade. While a small amount of money was to be earmarked in the FY 1953 budget for methods for increasing the effectiveness of institutions of higher learning and increasing the quality of training in the sciences, assistance and support would be primarily given to teachers of science participating in summer institutes. At these institutes teachers would keep abreast of new developments in their particular field, have an opportunity to carry on independent investigations of their own, obtain information on the latest techniques in teaching and in other ways to develop their usefulness as developers of scientific talent.

During the Senate Appropriations hearings on the FY 1954 budget, the point was made that lack of quality among secondary school teachers would have an effect on the production of scientists. The fiscal year 1955 budget contained a formal indication of concern for secondary school science education. The budget justification stated "The fact that over two-thirds of our high school graduates, having at least the intelligence of college graduates, do not enter college indicates that greater emphasis, encouragement and stimulation relative to the advantages of advanced study in the sciences as well as in other fields must be provided at the high school level if this potential is to be fully developed." In late calendar year 1954, it was pointed out that high quality scientists or engineers were not being trained in quantities sufficient to meet future combined civilian and military requirements. The FY 1956 budget stated that the "seriousness of the scientific manpower situation makes it imperative that the Foundation accelerate its program of education in the sciences as rapidly as possible." The budget element Education in the Sciences described the situation: "The widening gap between the demand and supply of teachers of science in the years ahead is possibly the greatest obstacle to the training of adequate numbers of high calibre scientists. Teachers, in order to teach and inspire more and better teachers of tomorrow must themselves be made more competent or imaginative and more stimulating. If they are they will help produce the many high ability students that must be inspired to pursue careers in science so that there would be assurance of an *adequate supply* of high quality scientists and science teachers in the future." The Foundation proposed that teachers from high schools and the small liberal arts colleges meet at institutes to learn from first-rate researchers and expositors about the more important and unifying concepts in their fields. These teachers, armed with new information, insight and enthusiasm would bring to their schools and students new thinking about their teaching materials, methods and objectives in the light of modern scientific research. Also a five-point exploratory effort was proposed. First, conferences at which outstanding scientists and teachers of science would gather to discuss new developments in science with a view to determining what place, if any, these developments ought to occupy in the science curriculum would be held; included were conferences directed toward consideration of support of college science programs for non-science students. Second, concepts and methods of modern science were to be incorporated into science curriculum at both high school and college levels by the preparation of syllabi-broad outlines of topics with examples of presentation and collections of appropriate new problems. The syllabi would be distributed to teachers around the country, adapted to local needs and thus stimulate the competitive writing of new and modern textbooks by the individual teachers themselves. Third, conferences between scientists and educators were proposed to develop experimental programs for the improvement of teacher quality. Fourth, effective teaching aids would be made available, particularly for those high schools where the staff was small and a science teacher would be expected to frequently teach courses in two or more fields of science. Fifth, special studies would be undertaken to determine the nature of the problem in improving science curriculum and training of science teachers.

During National Science Board discussions on science education in 1955 the NSB asked that primary consideration be given to the improvement of high school science curricula. A statement to the Senate Appropriations Committee on the FY 1956 Budget indicated the need for improvement of science curricula.

The Appropriation Act for 1956 established a floor on the availability of funds for the Summer Institutes for secondary school teachers which continued until the FY 1973 appropriation. This was in recognition of the importance placed on this form of science education by the Congress.

Stress was put on the fact that both short- and long-term programs were needed to increase the supply of competent scientists. Recognition was given to the fact that a considerable portion of the responsibility for attack upon the overall problem belonged to educational institutions and that ways and means must be found to stimulate and assist them in fulfilling their responsibilities. Arguments were given that the country had a grave, actual and potential shortage of scientific manpower and a critical limiting factor in developing latent science talent and productivity was a dwindling supply of science teachers. The Education in Science Program was expected to encourage universities to develop and offer as part of their regular programs more effective plans for training in-service and potential science teachers as well as encouraging secondary school administrators to provide science teachers with opportunities for obtaining additional training.

The FY 1958 budget highlighted for the first time programs for the improvement of science curricula as well as teacher training and early identification, motivation, and counseling of able students with scientific aptitude. The objectives of the education in the sciences program were stated as "to stimulate improvement of science teaching at all levels by supporting specially designed supplementary courses in science for high school and college science teachers, to stimulate the search for new and better ways of identifying and motivating people with scientific ability to enter upon scientific careers, and stimulating the search for new and better ways of training high school and college science students." The 1958 budget was the first in which funds for a Curriculum Development Program as a separate activity were requested. The bulk of the funds were to be directed toward supplementary teaching aids. A small amount of money was earmarked for subject matter syllabi for science teachers. This was to support efforts by various professional and educational organizations in reviews of the status of teaching materials in their fields and to develop syllabi reflecting current information and findings.

The thrust toward making more students choose careers in the sciences and interesting more in scientific research and teaching was continued in the fiscal year 1958 budget. Basic research had advanced knowledge at an unprecedented rate and far too rapidly to be reflected either in the training of science teachers or in the textbooks and other instructional materials which they used. The immense store of new knowledge had to be critically examined and those new crucial elements be selected for use, which together with the old, would provide the necessary foundation at each educational level.

The improvement of course content and instructional materials had two principal aspects, the development of new curricula materials based on new concepts and new advances in science, and the transmission of better course material (both new and old) to the teachers along with training in their interpretation and use. Training of science and mathematics teachers was to be by institute programs, science faculty fellowships, and other specialized efforts. All were focused sharply upon subject matter. It was accepted that the development of new curricula materials had to be a major effort if tangible results were to be produced within a reasonable time. Large amounts of materials were to be sifted and evaluated for retention or discard. The judgment of numerous experts in the particular field under consideration would be required.

There was a caution indicated: "Because the decisions are of such importance the Foundation is especially watchful, lest its role be misconstrued. In this program as in most others the Foundation *supports* the activities of competent persons and groups in the scientific and academic communities in carrying out what those communities judge to be needed and proper. The Foundation takes pains to avoid wherever possible the implication of endorsing or specifying attitudes, the nature of course content, or related items which are properly the province of the educational community. The initiative must derive from the academic community." (FY 1959 budget) Recognition was given to the fact that the selection of curricula items or concepts by competent specialists was only the beginning. The items had to be organized into course materials and made available both to teachers and students. It was obvious that an individual investigator or even a single institution could not find the resources required for a project of such magnitude. The Foundation was, therefore, giving support to careful reexamination and revision of the subject matter taught in certain of the scientific disciplines. The studies were undertaken by emminent scientists working in cooperation with competent and experienced teachers.

A major new element was established entitled Course Content Improvement Program. The justification was that a fundamental aspect of the solution to the problem of securing greater numbers of competent scientists and science teachers is providing strong emphasis upon development of new courses of study containing the latest knowledge appropriate for all levels of the educational system. We also begin to see creeping into the justification concern for relating science education to intellectual and cultural disciplines and the need of the responsible citizen to judge technological and scientific questions becoming important.

The fifties were a period of evolution as NSF worked to isolate the problem it wished to resolve. By the end of the decade, it was clear that substantial effort was needed in curriculum development and that there had to be some way of introducing the educational community to these new ideas. The program continued with two approaches—training of teachers through the institute program and the curriculum development effort.

Curriculum Development

The Foundation's Sixth Annual Report (1956) had identified science education from high school up through graduate school as a long range and continuing problem for American science. The report further indicated that resolution of the problem would require not only upgrading of the competence of instructors, but of the quality of courses being taught. The initial statement of general principles in support of course content improvement was developed and endorsed by the Advisory Committee for Education at its November, 1958 meeting.

In order to trace Foundation support for curriculum development it is advisable to place it in the context of other activities in the field at that time. Since education in the United States is traditionally a function of the individual states, responsibility for the development of curriculum studies and curriculum guides began and has remained with the States. Immediately following World War II several states and some large school districts allocated substantial staff resources to the development of curriculum guides but then, as now, the great bulk of curriculum materials were produced and distributed by the private publishing houses. There were indications in the early 1950s, however, that this pattern was changing. A number of Federal agencies had begun to use appropriated funds to augment the materials available for classroom use to update secondary and elementary science curricula. These efforts were not directed at complete development or revision but were rather to supplement existing curricula. The Atomic Energy Commission provided for the development and distribution of special instructional material dealing with new scientific concepts and findings and similar efforts continue to the present time.

Private foundations were beginning to support augmentation and updating of curricula. In 1951 the Carnegie Corporation provided support to the University of Illinois to undertake complete revision of the secondary mathematics curriculum in what came to be known as the University of Illinois Committee on School Mathematics. This development effort was continued for a number of years and ultimately was funded as well by the United States Office of Education. Another project was supported by the Foundation for the Advancement of Education to film a complete, although conventional, high school physics course and subsequently to evaluate its effectiveness in the schools of several states. In 1957, the same foundation made a grant to the University of Florida to produce a complete high school chemistry course on film. Increasingly during the 1960s, Federal agencies, including the Office of Education, expanded curriculum rebuilding to other areas including English and the social studies.

The initial entry of the National Science Foundation into the field of curriculum reform grew from an idea proposed by Professor Jerrold Zacharias at the Massachusetts Institute of Technology. Originally, the proposal involved only a film course on physics which would at once update the curriculum and bring high school students in touch with distinguished scientists. In fiscal year 1956, the Foundation granted an award of $300,000 for a feasibility study by a committee of physical scientists under Zacharias' leadership. A result of early meetings of the Physical Science Study Committee (PSSC) was the conviction that a mere filmed course was insufficient, and the plans for the PSSC moved toward development of an updated text as well as film, special experimental materials, and laboratory exercises.

In 1960, the Foundation made a grant to the American Association for the Advancement of Science to conduct a study of the place and character of science instruction in elementary and junior high schools. The study queried 200 leading scientists, teachers and school administrators during the 1960-61 academic year; they strongly recommended a large scale effort to develop scientifically sound and pedagogically feasible programs in science for students in the first nine grades. The steering committee of this project made recommendations which were included in an article in *Science Magazine* in 1961. These were:

> (1) science should be a basic part of general education for all students at the elementary and junior high levels; (2) instruction at the elementary level should deal in an organized way with science as a whole; (3) there must be a clear progression in the study of science from grade to grade; (4) there should be no single common national curriculum in science; (5) science teaching should stress the spirit of discovery characteristic of science itself; (6) new instructional materials must be prepared for in-service and pre-service programs for science teachers; (7) in the preparation of instructional materials, we require the combined effort of scientists, classroom teachers, and (8) there is a great urgency to get started on the preparation of improved instructional materials in science.

From 1961 through 1964 the Foundation funded several feasibility projects on the elementary school level; four of these became major curriculum development efforts. They are: Science Curriculum Improvement Study, University of California, Berkeley; Elementary Science Study, Educational Development Corporation; Minnemast Project, University of Minnesota; and Science, a Process Approach, American Association for the Advancement of Science.

The Foundation, therefore, began its efforts in scientific education with the primary goal of upgrading the subject matter knowledge of secondary school teachers in the belief that this would indirectly improve science education for students. However, reevaluations were changing the Foundation's perceptions of its means for carrying out its mandate. By the late sixties the Foundation had already supported 50 percent of all secondary science and math teachers in some form of institute activity.

The Seventh Annual National Science Foundation Report (1957) officially announced an organizational unit within the Foundation to consider proposals for curriculum development. Special Projects in Science Education had three principal charges: (1) curriculum studies; (2) student participation projects; (3) teacher training projects. The Curriculum Studies Group, known as the Course Content Improvement Program from 1957 through 1971, became the Curriculum and Instruction Development Program in 1972 and from 1973 until the present time has been called the "Materials and Instruction Development Section."

In 1962, the Foundation published "Science Course Improvement Projects" (NSF 62-38) to disseminate information on the projects it was interested in considering for funding. The first brochure as well as all subsequent revisions, the most recent of which is E-74-30 published in 1974, contain the following paragraph in the Foreward:

> The purpose of this booklet is to help make information widely available on science improvement projects supported by the National Science Foundation. Decisions on what to teach remain, in the healthy American tradition, the exclusive responsibility of individual schools and teachers. The National Science Foundation does not recommend the adoption of any specific book, film, piece of apparatus, course or curriculum. It is hoped, however, that the products of these projects will prove to merit serious consideration by every school and college.

The guiding principles for the development of course content projects stated clearly that NSF would support research and development on the substance of courses and the tools of instruction. However, Foundation funds were not to be used to promote the adoption of any specific curriculum course of instructional materials; they were expected to compete on their own merits. Each teacher and school must be free to decide if and how to use the products developed.

It became evident, however, that the diffusion and utilization of a radically new curriculum would not occur spontaneously. A basis for decisionmaking by teachers and school administrators was needed and therefore every effort was to be made to widely distribute project information. In addition NSF would provide for special training and technical assistance to effect full implementation.

In the area of curriculum development, the Foundation tried not to lead but to follow the consensus of both the scientific community and the Congress which had frequently urged that improved science teaching be extended to the secondary and then to the elementary schools. An indication of the concern of the Congress for improvement of education was demonstrated by passage of the "National Defense Education Act of 1958" which focused largely upon the improvement of education in mathematics, science, and modern foreign languages.

In 1969, the National Science Board requested the Advisory Committee for Science Education to evaluate the effectiveness of the Foundations' program in science education, including course content improvement, and to make recommendations for the decade of the seventies. That report recommended the following:

> Increased emphasis on the understanding of science and technology by those who are not, and do not expect to be, professional scientists and technologists.
>
> Greatly increased support for the social and behavioral sciences with particular emphasis on the area of pre-college education.
>
> First generation Course Content Improvement Programs still in progress should be supported to their conclusions.
>
> Second generation efforts should be focused on interdisciplinary, problem-oriented approaches that provide for differences in student abilities, backgrounds, and vocational objectives.

In 1973 following a reexamination and a reorganization of the Foundation's perceptions of its science education mission (a reorganization which included substantial inputs from the Office of Management and Budget), there was increased emphasis on the development of scientific literacy in all citizens and the establishment of an elementary and secondary school development program. This change is reflected in the *Guide for the Preparation of Proposals for Materials and Instructional Development Projects* (May 1974, E-75-3). The program policy emphasizes the complete freedom of the study groups to develop the materials according to their best judgment, which should not be unduly influenced by any pressure group or member of the National Science Foundation. "There must be no implication of governmental responsibility for, nor endorsement of, the content or organization of the materials."

Curriculum Implementation

The Foundation has increasingly recognized that the development of innovative curriculum materials is not of itself sufficient to assure utilization. Implementation is a complicated undertaking which begins soon after the development process is initiated. Creators of new educational materials start providing information about their activities to engender an awareness of the expected products. Another step in the development process- field-testing and trial use of materials-contributes to early dissemination efforts. Thus, there is no clear line separating materials development and materials implementation—they overlap and both are to some extent parts of a single process.

Normally, implementation is considered to encompass (a) dissemination of information about, and (b) activities which may lead to the adoption by schools and school systems of new educational materials and techniques. Visualizing implementation in this fashion leads to use of a multi-stage model for the implementation process. The first stage of the process encompasses awareness activities for the dissemination of information about materials to curriculum decisionmakers. This is followed by activities designed to develop an interest in the materials (i.e., training of resource personnel). Utilization on a trial or preliminary basis (which may overlap with final development) enables potential users to examine the characteristics of the materials in the field. Finally, adoption takes place at the school system or classroom level. At this stage implementation activities, such as orientation for key teachers, seek to bring about effective use of the materials by a critical number of the students for whom the materials are planned. The degree and nature of Foundation support has historically varied among these stages.

Although the Foundation has long been concerned with the effective utilization of curriculum materials developed with its support, its emphasis on implementation has become more apparent in recent years. The Foundation has provided support for a variety of implementation models, and its policies and procedures concerning implementation have tended to evolve. Tables 1-4 show in terms of dollars, and number of participants, the type of programs to be discussed.

The Pre-College Instructional Improvment Implementation Program officially began in fiscal year 1974 as the result of evolution of pre-college science education activities which first received NSF support in fiscal year 1954. These programs were multipurpose in nature and not solely directed toward implementation.

Early in NSF history it was determined that the Graduate Fellowship Program specifically mentioned in the original NSF Act was not necessarily the only or the most effective way to increase the research potential of the Nation. In fiscal year 1953, an experimental program of two summer workshops, called institutes, for college teachers were supported, followed in 1954 with support for three summer institutes for college teachers and one for high school teachers. These early institutes were patterned after industrial models, such as those supported in the late 1940's by General Electric, Westinghouse, Shell Oil and others. The institutes were generally of 6-8 weeks duration and in the early days restricted to concern with a single scientific discipline.

The original goals of these institutes were:

(1) to increase the effectiveness of teachers by broadening and updating their scientific background;

(2) renew interest in an attitude of teachers toward science and their task as a factor in the motivation and encouragement of their students;

(3) improve communications, sympathy and understanding between groups (researchers versus teachers, for example).

These original goals while remaining much the same brought forth additional and diversified objectives.

(1) updating of subject matter knowledge for those who were once adequately prepared;

(2) remedial training for teachers who were initially ill prepared;

Table 1

SECONDARY SCHOOL TEACHER EDUCATION PROGRAMS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

Fiscal Year	Summer Institutes			In-Service Institutes			Academic Year Institutes			Summer Conferences		
	1	2	3	1	2	3	1	2	3	1	2	3
1954	1	27	$10,900									
1955	6	143	72,350									
1956	18	750	383,750	2	90	$11,950	2	100	$504,700			
1957	94	4,800	4,878,462	21	635	150,350	16	781	4,250,885			
1958	122	6,200	6,543,625	85	3,000	623,780	19	925	5,144,300			
1959	327	17,000	19,114,056	184	8,725	1,861,685	32	1,508	8,648,580			
1960	351	17,350	19,994,600	191	9,026	2,179,670	33	1,491	9,015,600			
1961	355	17,692	20,838,200	253	11,633	2,887,555	40	1,494	9,470,470			
1962	413	20,469	24,071,800	284	13,826	3,597,040	52	1,725	10,979,700			
1963	416	20,450	24,139,200	268	13,436	3,512,780	56	1,755	10,985,000			
1964	431	20,355	24,175,776	282	13,085	3,524,080	59	1,685	10,997,500	2	55	$35,700
1965	441	20,492	24,295,230	313	14,460	3,614,543	64	1,644	11,021,990	7	322	113,000
1966	452	20,390	24,012,670	266	13,445	3,171,090	63	1,547	10,508,537	6	172	79,285
1967	428	19,393	22,791,300	270	12,941	3,375,515	63	1,503	9,781,500	22	627	249,080
1968	442	19,337	23,199,220	311	14,410	4,039,644	61	1,446	9,282,136	27	885	368,451
1969	421	17,823	21,432,483	279	12,914	3,560,476	67	1,367	8,924,768	16	473	208,324
1970	437	18,735	22,912,311	335	15,789	4,434,394	64	1,329	8,453,844	22	782	322,713
1971	428	18,549	22,772,970	226	11,663	3,376,263	28	444	2,722,693	29	1,069	421,165
1972	264	10,218	13,805,297	208	9,226	3,191,910	25	340	2,666,584	19	583	297,501
1973	237	8,454	11,292,037	39	1,697	517,565	23	369	2,378,950	19	583	291,050
	6,084	278,629	$330,705,337	3,817	180,053	$47,630,290	767	21,453	$135,717,737	16	5,551	$2,380,299

	Research Participation		
	1	2	3
1959	47	443	$601,230
1960	63	497	833,527
1961	51	351	691,405
1962	48	369	735,435
1963	37	304	650,530
1964	41	359	766,180
1965	44	355	763,445
1966	53	360	785,240
1967	60	377	816,300
1968	62	377	846,420
	506	3,792	$7,489,712

1 No. of Grants
2 No. of Participants
3 Amount Obligated

Table 2
COOPERATIVE COLLEGE-SCHOOL SCIENCE PROGRAMS (SECONDARY AND ELEMENTARY) SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

Fiscal Year	1	2	3
1960	1	Not Available	$53,090
1961	19	55	367,185
1962	34	280	525,530
1963	44	689	744,130
1964	42	934	749,525
1965	46	1,576	913,330
1966	56	3,230	1,929,305
1967	56	3,424	2,296,295
1968	84	4,502	3,182,795
1969	146	7,191	5,596,241
1970	148	6,309	5,441,931
1971	158	6,296	4,898,741
1972	142	8,435	4,568,081
1973	81	4,247	2,376,256
	1,057	47,168	$33,642,435

Table 3
RESOURCE PERSONNEL WORKSHOPS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

Fiscal Year	1	2	3
1967	6	178	$297,000
1968	18	733	862,637
1969	26	868	1,374,500
1970	31	1,092	1,259,183
1971	36	1,347	1,517,265
1972	25	885	1,246,800
1973	9	396	522,700
	151	5,499	$7,080,081

Table 4
ELEMENTARY SCHOOL TEACHER EDUCATION PROGRAMS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION

Fiscal Year	In-Service Institutes			Summer Institutes		
	1	2	3	1	2	3
1959	11	345	$80,600	12	515	$470,300
1960	13	405	73,990	16	545	522,100
1961	35	1,029	200,930	19	649	656,500
1962	35	1,060	202,665	21	712	710,100
1963	46	1,423	299,760	34	1,046	1,062,300
1964	70	2,118	464,630	37	1,236	1,270,789
1965	62	3,082	466,040	39	1,459	1,271,860
1966	55	4,225	513,790	26	926	769,850
	327	13,687	$2,302,405	204	7,088	$6,733,799

(3) specific background training to equip teachers to teach newer curricula materials;

(4) training in depth to enable teachers to meet new higher standards (such as those represented by a Masters Degree);

(5) advanced specialized training for teachers and supervisors preparing for positions of leadership in science education.

Priority ranking of these objectives varied between the various institute programs and shifted over time. For example, in the earliest years objectives (1) and (4) (updating of subject matter knowledge and training in depth) were the sole objectives addressed by institutes. But by the 1970s specific background training and advanced specialized training (objectives (3) and (5)) became vitally important.

Remedial training for teachers became a recognized need with the 1956 program. In fiscal year 1958 these institutes became a vehicle for training teachers in the utilization of newly developed curriculum materials. This shift in emphasis can be traced to the work done by the Physical Science Study Committee which recognized that teaching materials being developed were such a radical departure from what had been used during the past fifty years that all teachers needed more training if they were to handle the new courses.

Five summer institutes held in fiscal year 1958 were oriented to the Physical Science Study Committee's program. In the next year there were 13 such programs. As new course materials became ready for classroom use, institutes were established to handle the orientation of teachers to these new curricula. These institutes enabled teachers to learn more subject matter and to see the relevance of new subject matter in the courses they taught in high school. By 1965 it was estimated that approximately 20 percent of the summer institutes had a major orientation towards one of the revised curricula. This percentage did not vary too much from then until 1973, the formal termination of the summer institute program.*

By 1956-1957, it had become clear that high school teachers' background in subject matter was even weaker than had been anticipated. A new program, Academic Year Institutes (AYI), was characterized by full-time programs of intensive study leading in many cases to a masters degree. From the beginning the program focused mainly on the objectives dealing with updating of subject matter knowledge, training in depth, and advanced specialized training for teachers. Degrees especially designed for teachers were established bearing such names as Master of Science Teaching, Master of Arts in Teaching, and Master of Education. Starting about fiscal year 1966 the AYI program moved more strongly to provide leadership training for supervisors and curriculum specialists instead of for the regular classroom teacher. While not starting out to be a direct implementation vehicle, the AYI program by fiscal year 1973 was totally devoted to providing leadership training for supervisors and curriculum specialists in implementation strategies and means for improving the secondary school curriculum in science and mathematics. In fact, in fiscal year 1973, the program name was changed to Leadership Development Program. It should be noted that the program was not limited to just NSF supported materials.

In fiscal year 1956, in response to teacher interest in receiving training on a part time basis during the school year, a program of In-Service Institutes was initiated. It had the whole range of objectives as stated above for the Summer Institutes. The major difference besides format was the clientele attracted by these In-Service Institutes. The Summer Institute and Academic Year Institute Programs generally recruited nationally and attracted as participants the younger, better trained teachers. The In-Service Institute participants were the older, less well-trained teachers who were unable to leave home in order to undertake a full-time program of study.

Discussions concerning the advisability of providing training opportunities for elementary teachers began several years before formal establishment of a program of summer and in-service institutes for these teachers in 1959, although there had been several experimental projects held before that time. It was believed that since most elementary school teachers did not teach science as such, a more realistic approach might be through institutes for science supervisors in school systems where science is given considerable attention in grades up through seven.

Every elementary school teacher was potentially a science teacher since there was little departmentalization at the elementary level. Emphasis was therefore placed on training key teachers and supervisors who might be able to influence others in their schools. It was also hoped that these teachers, along with their colleagues at the secondary level, would conduct in-service training in their local area for elementary personnel. The elementary summer and in-service programs were not a major implementation device. They could not get a critical mass of teachers trained at one locale as a practical matter, and the program was terminated in fiscal year 1966 as new elementary curricula were beginning to become available.

A Science Training Program for High Ability Secondary School Students had centered its attentions on the needs of student participants. Some projects involved the introduction of materials from the program activities into the student's high school, which required the involvement of high school teachers. In 1961, this became a separate program. The Cooperative College-School Science Program (CCSS) was seen by some institutions as an opportunity to help introduce new course materials in mathematics or chemistry into areas of the country where they had not yet taken hold. In fiscal year 1962, curriculum implementation appears as an element of the program. In fiscal year 1963, two types of program activities were supported, those whose main function was working with high ability students as in previous years, and those which involved collaborative efforts of college scientists and secondary school systems in improving the secondary programs in science and mathematics. The essence of the program was the attempt by colleges, universities and research institutions to work changes in high school science by a combination of precept and example. The earliest programs took place in the summer and on weekends during the academic year, were participant-centered, and their effects on school systems were transmitted through students and teachers, with students hopefully bringing a sense of need and urgency back to their schools while the teachers brought back answers to that need.

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* The cited percentage includes only those institutes specifically labeled with one of the curriculum alphabets.

Several institutions devised CCSS programs with the immediate purpose of helping schools introduce new course material. In some of these the student participants played a role as demonstration classes for teacher retraining. In others, students were not included and in a few, the secondary teachers were eliminated as regular participants. A general consultative relationship was established between a college or university and a school system.

With the termination of the summer and in-service institutes for elementary school teachers in 1966, this program became the sole vehicle supported by NSF for assisting elementary school personnel to receive training. The bulk of proposals concerning elementary levels received in 1968 and in later years were based on projects aimed at the implementation of NSF-supported curriculum materials. On the other hand, many of the secondary school proposals requested support for non-NSF curricula and locally generated materials. For example, in fiscal year 1972, nearly all the elementary grants involved the implementation of national curriculum materials, while less than half of the secondary grants were so oriented.

In 1968, a program recommendation memorandum pointed out the need for supporting a significant number of projects in implementing elementary sciences. It pointed out that teachers were very poorly trained, usually with no science background at all. Traditional course content had been so poor that students had practically no framework upon which to build more sophisticated secondary school science content. Traditional sources of help available to elementary schools for their elementary science curricula had been quite poor and had failed to do an adequate job up to this time. With new materials appearing it was essential that these new materials be introduced with intelligence and competence.

It recommended that NSF provide substantial guidance on the kinds of training teachers should have as well as the kinds of persons who should be influential in training the teachers. An essential element is feedback from the classroom to the training cadre particularly in the beginning of the implementation process. The thrust of the program, therefore, was for NSF to support a sufficient number of exemplary programs in this area. NSF wished to be able to implement some excellent and substantive course materials in elementary science while at the same time forming new bonds between the elementary school system administration and competent science educators in the colleges.

Beginning in 1969, the program sponsored a series of conferences to disseminate information about new curricular efforts. The emphasis was an orientation of college level science department members and science educators capable of helping to disseminate the new course content materials and who were available to serve as consultants and project leaders for school systems which intended to implement the materials in their own classrooms. Extremely few scientifically-trained professionals with detailed knowledge of the content and approaches of the new science curricula were available to help introduce the new materials in a valid manner. This experimental program was subsequently supported under the label of Administrators' Conferences and administered by the Course Content Improvment program.

In 1966, it became apparent that several forces, mostly external to the Foundation, had combined to make it necessary to re-examine some of the operating assumptions at NSF with regard to curriculum implementation. An exploratory conference on implementation of science curriculum improvement in elementary schools was held at the University of Maryland Science Teaching Center in January, 1967. The impetus for the conference came from the increasing recognition on the part of the Foundation staff that the development and availability of improved curriculum materials does not of itself guarantee improvement of science education in the classroom, especially at the elementary level, nor is upgrading of teachers competence in subject matter sufficient to effect improvement even if it were possible to reach the million elementary school teachers with instruction in the several scientific disciplines that the new elementary science curricula drew on. The conference explored, with a small group of people from selected elementary level course content improvement projects and science teaching centers, the development of mechanisms for more effective implementation of science education based on the current curriculum innovations.

The conference suggested:

(1) Orientation of the staff of existing course content improvement projects to allow project involvement in implementation activities to a greater extent than previously;

(2) operation of training sessions with respective resource people.

Suggestions included (a) involvement with one project in depth; (b) participants to include college faculty, curriculum specialists, other supervisory school personnel, teachers and principals, or teams of the above designed to affect local systems; (c) training periods of from 1 to 8 weeks, the sponsorship by a number of agencies such as universities, science teaching centers, regional laboratories, (d) elaboration of long-range plans for implementation activities.

The Pre-College Education in Science (PES) Annual Report for 1967 pointed out that the many programs undertaken to improve instruction in science and mathematics in elementary and secondary schools had not succeeded to the degree hoped for and needed. The assessment was that these programs did not achieve the level of impact of which they are capable largely because their efforts did not include effective procedures to bridge the gap between curriculum and innovation, under the leadership of scientists, and classroom instruction, under the administration of school officials.

Course materials had been developed with the collaboration of specific schools in thorough classroom trials of preliminary versions. In other respects, the work had proceeded outside the purview of school systems. The training of teachers to use new materials and approaches through institute programs had emphasized meeting the needs of the individual teacher rather than the needs of a specific school system's program by the development of a corps of teachers. While this pattern of support enabled innovative individuals to do effective things without the necessity of having to collaborate with a system whose internal forces tended to perpetuate the status quo, it had not produced the widespread changes hoped for and needed in the classroom. In 1967, a number of grants were made for conference workshops to train resource people, in some cases as individuals, in other cases as teams, to advise and work with the schools and school systems interested in adopting new curriculum developments. The trainees were drawn from science educators in colleges and universities, from members of curriculum study groups, school superintendents, principals and teachers who had demonstrated interest in elementary science education.

In fiscal year 1969, the purpose behind these grants, as described in the PES annual report for that year, was to find a mechanism to insure the wide availability of highly qualified assistance to schools wishing to use materials, a mechanism not requiring a large continuing Foundation investment perpetuating the curriculum development group after their substantive work is done. The training opportunities were to be offered primarily to those who could be expected to train others (multiplier effect) rather than to those who would be involved only in teaching their own classes. In fiscal year 1970, a greater share of the course content improvement program went into this implementation activity recognizing that this type of project was important in assuring the successful introduction of new materials into schools through the training of a critical mass of resource personnel. Even though there was no restriction with regard to the use of non-NSF materials in resource personnel workshops most of the projects supported through this program involved NSF-supported curriculum endeavors.

Foundation policy in this area, as in the area of commercial distribution and financial arrangements, had been influenced by the necessity of avoiding the direct promotion of school system adoption of material developed with Foundation support. The Foundation recognized that traditionally full responsibility for the selection of curricula in the U.S. rests with appropriate local school authorities. Therefore, the Foundation has consistently refused to provide funds for sales promotion and activities of a similar nature. On the other hand, with the increasing investment in curriculum materials, it has become more evident that the Foundation must accept some responsibility for assuring accepting and use of the materials. The Foundation has sought to maintain a proper balance between these two somewhat competing considerations.

As a result Foundation support for curriculum implementation has tended to correspond more with the earlier stages of implementation. The paucity of individuals competent to assist schools and school systems in implementing innovative curricula led the Foundation at an early date to support leadership development projects involving training of resource personnel in particular curricula. These personnel were then able to assist local schools and school systems in introducing (at the latter's option) new instructional materials by conducting dissemination and training activities. Prior to 1973, such leadership projects were funded through the NSF Course Content Improvement Program (which was primarily concerned with curriculum development).

Support for curriculum implementation was, however, in the past dispersed through the various Education programs. One program which provided substantial support for implementation activities was the longstanding and well-known NSF Summer Institutes Program. The same was true of the In-Service Institutes Program. Proposing colleges and universities could submit proposals designed to assist schools and teachers in their areas in introducing new curricular materials such as PSSC, BSCS, and Chem Study. These activities involved later stages in the implementation process than did the leadership projects, but were still considered appropriate for Foundation support since the decisions to use the materials had been made by the teachers' local schools. In some cases where close cooperation with a particular school system was deemed advisable proposals could be submitted to the NSF Cooperative College-School Science Program.

In all these programs unsolicited proposals were submitted by colleges, universities and appropriate nonprofit organizations. While the extent of curriculum implementation supported was to a considerable extent a function of the proposals received, funding allocations and curricula priorities were determined on a year-by-year basis by the Foundation. At any one time a certain percentage of the activities supported by these programs could be identified with specific NSF-supported curricula. In 1965, for example, roughly 20 percent of the NSF Summer Institutes had a major orientation toward one of the NSF-supported curricula. Grants were awarded to the host institutions to support these activities.

Except for those aspects of development which must overlap with implementation, such as information dissemination and leadership training, direct Foundation grant support for implementation activities has not been provided to the grantee-developer of curriculum materials. For the most part such grantees have obtained support for implementation activities through other means. Frequently, publishing agreements for NSF-supported materials provide for activities such as information dissemination and teacher training to be performed by the grantee-developer at the publisher's expense. These activities supplement those supported directly by the Foundation.

In the past several years, partly in response to pressures from the Congress and the Office of Management and Budget, the Foundation has revamped and stepped up its implementation efforts. The Foundation has established a separate program of Instructional Improvement Implementation at the pre-college level which provides a sharper focus for curriculum implementation activities. The program is based on the premise that NSF can most effectively further utilization of curricula materials by supporting a few high-visibility models intended for a variety of learning situations. In the selection of materials for implementation the program emphasizes nationally recognized curricula, which includes but is not confined to materials developed with Foundation support.

National Science Board Involvement

In the earliest years of the Foundation, National Science Board approval of many activites, including science education, was provided through consideration of the budget submission and allocation for each year. Specific "Education in the Science" proposals were brought to the Board for approval only if they exceeded the Director's authority ($250,000, later $500,000). However, the Board did receive reports from the staff from time to time on both the programs which were under way and the plans for developing new activities or launching experimental programs. For example, the Board followed closely and received presentations directly from the developers of the Physical Science Study Committee (PSSC).

The first specific Board involvement was in 1955 when the budget for science education was submitted recommending an allocation for improvement of science curricula and teaching training. At that time the Board asked that primary consideration be given to the improvement of high school science curricula.

The Course Content Improvement (CCI) as a program element appeared in the budget in 1956 but the Board's records do not show that it was specifically approved or that guidelines were provided for it.

During the next several years the NSB had the opportunity to discuss several proposals relating to curriculum development. In 1958, the NSB was advised of the assumption of responsibility by Education Services, Inc. (ESI) for the Physical Science Study Committee (PSSC) project. In 1961, some concern was expressed as to the advisability of giving general overall support to ESI even though the PSSC had received high ratings.

In 1961, the NSB approved the CHEM Study grant, and in 1962, approved support for the Association for the Advancement of Science (AAAS) project. In September 1963, the NSB approved the first MACOS program; this was identified as ESI's Social Science Program. The terminal grant for CHEM Study was also approved.

In January 1965, the Board reviewed and approved the second MACOS proposal submitted to the Board, $1,829,903 for 20 months to ESI for a Social Science Curriculum project (under the direction of Jerome S. Bruner.) Prior to approval, the Board raised three questions: (1) Is a Board committee considering the proper distribution of total effort between science education activities and the support of basic research? The reply was that Committee I was considering short-range and Committee III long-range aspects. (2) To what extent is ESI financially dependent on NSF? The reply was that NSF, over 6 years, has furnished a large total amount, varying in percentage annually. These sums support projects, not ESI as an organization. (3) Which organization benefits from sales under science education activity grants? It varies. ESI segregates such income in a special account, and the portion constituting profit is returned to Treasury. . . Several Board Members spoke in favor of supporting the project on the grounds that a novel approach in social sciences would stimulate others to undertake curriculum improvement projects. . A third MACOS grant was approved in September, 1966 for $1,597,000 for two years.

In September 1968 an award was approved for a "Social Sciences Curriculum Program" (SSCP) for $528,400 for one year to the successor of ESI, Educational Development Center, Inc. (EDC).

In September 1972, the Programs Committee reviewed the fiscal year 1972 annual CCI report. Following the Committee's review and on its recommendation the Board approved 5 large proposals including one from EDC "Exploring Human Nature" for $550,000 for one year. The Programs Committee requested that these proposals include more information regarding reviews, salaries, etc., and expressed some concern for the progress of the entire program. This prompted them to ask for an assessment of the future use of current materials being developed to determine whether the needs are being adequately filled.

In September 1973 the Committee recommended approval of a proposal for AAAS but raised numerous questions regarding one from EDC for "Unified Science and Mathematics for the Elementary Schools" (USMES) for $622,300. Subsequently, the staff withdrew the proposal in order to clarify certain items (e.g., high travel costs) prior to Board consideration. This original request was for one year. This latter proposal was submitted again in October 1973.

The Board approved the resubmitted USMES proposal from EDC for $486,500 for 10 months. The minutes read as follows:

> This revised USMES project was resubmitted by the staff under the direction of Dr. Paige. Continued support was proposed for USMES which has been developing interdisciplinary units based on real problem challenges to students, together with the materials, resources, teacher training, and organizational features needed for effective implementation. Seven units are in progress; eight have been developed; ten are in the planning stage. The staff feels that the project is progressing well and that, when 25 or 30 units are completed, school districts or a commercial publisher will be interested in the publication and distribution of these materials and the development of others.

In addition to approving selected proposals, the NSB has over the years evidenced interest in the curriculum program. In November 1961 upon the advice of the Divisional Committee for Science Education, the Board supported the establishment of a special committee under the American Association for the Advancement of Science (AAAS) to coordinate efforts to improve instructional materials.

The Board minutes for March 1963 indicate that there was some concern over the high cost of Course Content Improvement (CCI) projects. Later that year the Board in considering budget justifications, discussed an understanding between NSF and the Office of Education clarifying NSF's focus on CCI.

In September 1963 while approving the terminal grant for CHEM Study and the first MACOS proposal, the staff advised of the policy on royalty income:

> All grants being made in the Course Content Improvement Program which involve possible royalties from sales or rentals of films provide that such "income" is to be placed in escrow accounts to be used as directed by the Foundation. Such funds may be required to be returned to the Foundation and up to the amount of the grant, may be used for its general purposes*

In connection with approval of several CCI proposals the Board Members expressed concern regarding the stability and fiscal responsibility of groups receiving CCI grants. Additional concern was voiced over whether these programs would offer balanced education. The statement was made that if NSF is a large contributor to the budgets for such groups it has more than usual fiscal responsibility concerning their status.

In March 1965 the Board Chairman asked that recommendations for future plans for the entire CCI program be submitted for detailed consideration by the Board. The minutes indicate that the Board Members were in agreement that the Foundation should reserve the right at all times to terminate CCI projects and to avoid developing monopolies. In the discussion of a Biological Sciences Curriculum Study (BSCS) proposal which was approved at the meeting, caution was also expressed about imposing arbitrary rules limiting support to a fixed number of years on the ground that such a limitation could exclude certain desirable continuations or extensions of the programs.

In May 1965 at the request of the Subcommittee on Science Research and Development of the House Committee on Science and Astronautics, the staff prepared for it and for the Board a "Status Report on the CCI Activities of the NSF." This was the first policy statement to be provided to the Board on this program. Relevant points in the statement were discussed and generally agreed upon in NSB Committee III (Memorandum of Discussion of the Fifth Meeting on May 5-6, 1965 is on file). The Committee concluded that:

1. CCI projects should be an initial venture to be transferred at a later date to outside groups;
2. responsibility for stimulating and supporting such a program resides in the Federal Government; and
3. career curriculum improvement groups should be avoided.

Committee III also suggested site vists by Board Members to aid in the formulation of an acceptable policy. (Subsequently, several such site visits were made including one to ESI in Cambridge, Mass.)

During a discussion of the Course Content Improvement program in November 1965, the Board again reiterated previously expressed conclusions;

1. There should be developed no "special" corps of course content revisionists", but new people should become continually involved in these problems; and
2. As a corollary, no group of people involved in course content activities should be encouraged to perpetuate themselves.

In an April 1966 discussion of the interrelationship of NSF with the newly formed agency, Office of Education, it was agreed that NSF's Course Content Improvement program should be continued. At this meeting it was reported to the Committee that the Bureau of the Budget and the Office of Science and Technology, ". . .favor continuing NSF participation in CCI activity because of their belief in the desirability of the type of approaches which the Foundation has used. . ." There was a general agreement that the Foundation should not withdraw from course improvement but that it should expect to be supplanted in some areas by the expanded OE activity.

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* The re-use of the funds was later declared to be illegal by the GAO and the NSF practice was revised in November 1971.

In June of 1966 the Board requested for the first time that an annual review of the CCI program be presented to the Board as well as a block presentation of its programs to be funded and that this review and presentation should be provided to Committee III for consideration and the formulation of recommendations to the full Board for action. The first annual report on the CCI program was made to the Board in September 1966.

In February 1967 Committee III was informed that it was the policy of the Foundation to consider support of CCI activities up through a first revision of materials. After that time it was proposed that projects be placed in the "public domain" through the mechanism of free licensing. Future revisions could then be undertaken irrespective of the sources of support.

Committee III was advised in September 1967, that funding for CCI projects was normally planned two years in advance. It was expected that as older projects were terminated funds would become available for new projects since there was no shortage of people interested in participation in this program. The second annual CCI report to the Board was also presented in September. Committee III reported to the full Board its detailed review of the program and expressed its satisfaction with management and effectiveness. The Board approved continued support of the recommended programs.

In January 1968, there was discussion of proposed programs to help disadvantaged students on several academic levels through various programs including CCI. Committee III endorsed this proposed venture within budgetary and statutory limitations. During the Committee's discussions it was pointed out that implementation of CCI programs is dependent upon administrative decisions at the local school system level. In March the Board agreed on general NSF policy for publication procedures, production and distribution of materials and income utilization for CCI. (copy in file)

Later in 1968 a Board Task Force on Science Education (a subset of the Programs Committee) reported that it had reviewed the CCI annual report, examined the programs carefully, and recommended that the Director be authorized to continue certain projects.

The Task Force on Science Education considered a paper (copy in file) concerning methods for evaluating NSF's Curriculum Development Program. Discussion centered around the desirability of setting up and supporting a project to evaluate the various course content improvement programs, including consideration of design for guidelines for the next generation of CCI materials. The concept of such a project which would involve an outside grantee or contractor was to be presented by the Task Force to the Programs Committee at its next meeting.

In September 1970, the Board received its fifth annual summary of the CCI programs. The Advisory Committee for Science Education reported its findings and the Board Chairman reiterated support for NSF's educational activities and the hope that the Foundation would continue support especially at the pre-college level despite the formation of the new agency, the National Institute of Education. The Board asked its Long-Range Planning Committee and the NSF Executive Council to give priority to the development of a long-range plan for the support of science education.

After the September 1971 meeting, the Programs Committee which had now been commissioned to review on behalf of the Board the annual CCI report as well as all proposals under the program announced that it was satisfied with the status of the CCI program. The Programs Committee discussed with staff members external evaluations of the programs and posed several other questions concerning CCI all of which were satisfactorily resolved. In a report to the Board the Advisory Committee for Science Education stated the future of CCI was promising and it was one of NSF's most important activities.

The Director informed the Board in November 1971 of a revised policy regarding disposition of income generated under education grants to become effective immediately. The following is excerpted from the minutes:

> Income will be applied to offset costs of grant activities as well as costs of administration of the income-producing properties. When income is not expected to exceed $10,000, the grantee may keep and apply to research and education in the science amounts remaining after offsetting costs. However, any income remaining after payment of costs, which exceeds $10,000, will be remitted to the Foundation. Where total income is estimated to exceed $10,000, the grant will provide specifically for disposition of income. Income not used as provided for in the grant will be remitted to the Foundation. With respect to contracts, income received will normally be applied to offset costs chargeable to the contract, and any income not so used shall be remitted to the Foundation.

In September 1973 the annual report of the "Materials and Instruction Development Program" (MID), formerly the Course Content Improvement Program, was presented to the Program Committee. It stressed changes in the overall education program and how emphasis was shifting as a consequence, with the thrust being toward modularization or delivering "methods of education" rather than on "tight course content." Questions were raised as to the level of current expenditures as compared to earlier years and also about the ranking of schools in a priority context. It was stated that expenditures were substantially lower, perhaps by as much as one quarter as compared to six years ago, and that elementary school mathematics would be high on the priority list for the next two or three years. The Committee indicated that there might be too much stress being placed on mathematics and science curricula to the detriment of the social sciences. Actually, the bias had been the other way, but at the secondary rather than the elementary level.

In October 1973, the Programs Committee discussed a proposal from EDC. The record of that meeting includes the following:

> The AD/E indicated agreement with the recommendation of the Board's Ad Hoc Committee on Science Education that the highest priority in science education be directed at "the development and maintenance of exceptional high quality doctoral and postdoctoral programs to produce the best basic and applied research talent in the country." He also shared the Committee's concern that there should be a close linkage between education and research. The recommendations which the staff has made to meet Congressional requests for minimal graduate student support in the fiscal year 1974 are in line with these concerns.

The Committee and staff seem to be in reasonable agreement on the highest priority, and it is abundantly clear that the Committee did not imply that all available funds should be obligated to these concerns. Science literacy required more curriculum research and development. Here the question is "how" not "why". Dr. Paige assured the Committee that he did not plan to squander available funds on dubious projects nor did he wish the Directorate to become the Inspector General of a fullblown production operation. However, he did believe the commitments to a project during the research and development stage must extend to the point where it could be stated that: "Here is curriculum material that our evaluations indicate is responsive to national needs; it is different; it is in sufficient quality to be implemented today for your independent testing; and, if you find this material successful, we urge you to encourage commercial concerns to expand on NSF's pioneering efforts."

In September 1974, the Programs Committee received and discussed the MID annual report for fiscal year 1974. There were no special questions from the Committee. The Board also received the annual report with the notation that the principal thrusts in pre-college education at the elementary level are for education for science literacy and for careers in science. During that year 56 proposals were received and 43 grants were made totaling $8,211,021.

Legislative History

There has been regular interaction between the NSF staff and the Congress particularly in the annual appropriations hearings and, after the revision of the NSF Act in 1968, in authorization hearings as well. There have also been several oversight hearings and reports issued, including one on *Science Education in the Schools of the United States* in 1965.

The Committee Reports of the early years typically contain few comments regarding programmatic activities, although the hearings contain much discussion on various aspects of the programs. It is House Report No. 1477 on the FY 1967 NSF Appropriations Bill that first makes any mention of the fact that the Foundation supports the development of course materials for the teaching of science in primary and secondary schools.

During the early years of hearings on the Foundation's appropriations, discussions relating to education dealt primarily with training of graduate students, although there were some references to the quality of faculty at the undergraduate level.

During the hearings on the *FY 1954* budget, in a discussion between Senator Magnuson and Dr. Waterman, the point was made that the lack of quality among secondary school teachers would have an effect on the production of scientists.

The Foundation's budget presentation for *FY 1955* contained for the first time an explicit entry dealing with education in the sciences. This activity included summer institutes for college teachers, a program of research opportunities for college teachers during the summer, and the beginnings of an education in the sciences support activity at the secondary school level. The primary emphasis, however, both in the budget and in the discussion during the hearings was still on the graduate fellowship program.

In a summary statement submitted for the record in the *FY 1956* hearings, the section "Education in the Sciences" included, for the first time in a Congressional hearing, a specific need for improvement of science curricula.

For the next several years the need for improving capabilities of secondary school teachers and content of courses was discussed in the Appropriation hearings. The degree of control or authority that the Foundation should have over the course of science in the country was a consistent matter of concern. On January 30, 1956, Dr. Waterman stated, "Our whole setup, thoroughly endorsed by the Board, is such that we do not attempt to exercise control of science, but rather by use of the guidance of leading experts in the different fields of science, we find from them the direction in which science should move. This gives us the basis then on which we plan our programs. It is a method which has proven very successful."

During the hearings on the *FY 1957* budget Congressman Albert Thomas, Chairman of the House Appropriations Sub-committee put forth several suggestions which indicated a willingness on the part of the committee to expand high school teacher training programs. The indications were that Thomas believed it wiser to spend money on educational programs rather than on equipment for basic research or policy studies. Because of the emphasis on high school programs, NSF was asked if it could use $10 million more for high school teacher training. When it became clear that the source of the additional money would be other NSF non-education programs, the offer was declined. However, the Appropriation Act for FY 1957 included a "limitation clause":

> Provided, that. . .not less than $9,500,000 shall be available for tuition, grants, and allowances in connection with a program of supplementary training for high school science and mathematics teachers.

While the Senate recommended deleting it, this limitation, in varying amounts and minor changes in wording, remained in NSF appropriation language through the FY 1973 appropriation.

The FY 1958 budget was the first in which funds were requested for curriculum development. The appropriation subcommittee was advised that support would be given to efforts to improve course content and presentation of material by revision of course outlines by regional conferences of teachers, administrators, educators, and scientists, to discuss means for improving courses, and by the development of modern teaching aids of particularly high quality. Concern was evidenced for the competency of high school teachers. Dr. Waterman stated, "Our position in the Foundation is that, if there is any way possible, this should be done in the traditional way, by the local mechanisms—the communities, the school boards, and the States. If they are convinced that this problem is acute and needs attention, they can take the right steps more simply and I think most effectively. But, my personal opinion is that we see that something is done—hopefully that it can be done locally. That is the way, but it seems to be the Federal Government must be in the position to stand behind this whole thing and see that action is taken."

During the FY 1957 hearings in a discussion of the need for stimulation of students' interest in science at the pre-college level, Mr. Boland had suggested that stimulation should go back beyond the high school to the grammar school level. In the hearings for FY 1958, in a discussion with Dr. Bronk, then Chairman of the National Science Board, of children learning mathematics, Mr. Boland stated, "I think you have to go beyond the high schools. I think you should go into the grammar schools and make mathematics attractive there."

During hearings before the Subcommittee of the Committee on Appropriations, United States Senate, 85th Congress, Second Session, May 12, 1958, on the FY 1959 budget, Dr. Waterman stated to Senator Magnuson, "Secondly, we need quality in training. We must insist upon that. This means superior teaching and superior teachers together with the equipment and materials that they must have." When talking about the education programs, Senator Magnuson asked, "In some cases the States have requested the Science Foundation to go into this field even to the extent of revising the curriculum in high schools, but you only do that upon request." Dr. Waterman, "That is right." Senator Magnuson, "You do not interfere unless they ask you to interfere.?" Dr. Waterman, "No, we do not interfere. You see this characterizes our program. We get the requests. Then we analyze and we select the best ones (proposals) so our program continues to be selective." Senator Ellender asked if NSF work is solely related to science and was told, "Solely to science." The Senator later stated: "Today's students all aim for the easiest way out, and I do not know of a better thing that this Foundation could do than to help to reestablish secondary school systems. It is then that we should give our students the proper training because it is from there that you get scientists."

In the hearings on the FY 1960 request before the Subcommitte of the Committee on Appropriations of the House, 86th Congress, First Session, in a discussion regarding the authority of the Foundation to improve elementary and high school curricula, Mr. Jonas indicated that his interpretation of the Act is that the Foundation has a broad authority to strengthen curricula and stated, "I do not see anything in the Act, as I recall it, that would prevent your working with the State school authorities in an effort to strengthen local curriculum."

Later in the discussion Mr. Thomas also stated that, "The language of the Act is broad enough to do practically anything you want to. Now it is a question of what you do in connection with the Department of HEW and others and where you are overlapping. Now if you did not have the Department of HEW, you could do anything you want to under it (the Act). Is that not a reasonably accurate statement?)) Dr. Waterman replied, "I would suppose so." Mr. Jonas then stated, "That section 3(a)(1) is open-ended I think. I do not see why you would have any difficulty doing what I have suggested under that very first authority."

During the hearings on the appropriation for FY 1961 Congressman Thomas after extensive discussion of the Course Content Improvement Program expressed the opinion that "It is the best part of your program."

There was a discussion of royalties expected to be received. The publication of materials financed by NSF was also discussed and assurance given that no individual profits from this activity.

The hearings on FY 1962 focused on the costs of a Course Content Improvement Project, the cost of a textbook, how it would be distributed, and the fact that it must make its own way.

The Hearings for FY's 1963 and FY 1964 contain little in the way of substantive discussion on the Course Content Programs.

In the hearings before the Subcommittee of the House Committee on Appropriations on the FY 1965 budget most of the statements concerning the Course Content Program came from NSF. In his testimony, Dr. Bronk stated, "I would stress the following as being the most significant function of the National Science Foundation: to train people to be able to deal with what is going to be required of them but cannot be anticipated; and to develop understanding of what is already known and to discover new knowledge for the development of our country."

Dr. Handler, a member of the National Science Board stated "There is in this document (the budget document for FY 1965) an expression of what Harvey Brooks of the National Science Board called the social invention. It is a remarkable one. This is a Course Content Improvement Program. I must confess when I first heard of it I took a rather dim view. I have to apologize." Mr. Thomas asked, "This is Dr. Zacharias' project?" Dr. Handler replied, "Yes. He invented something not merely the program itself. . .I thought this was an enormous amount of money to spend on. . .a few textbooks and teaching materials. It could not have been done any other way. . .it makes the best of man's endeavors available to the whole population."

"The policy framework within which the science education programs operate require (1) that they supplement rather than replace traditional forms of support; (2) that no measure of control is assumed over the processes of education; (3) that the fullest involvement, cooperation and advice of the scientific-educational community is obtained; and (4) the improvements are sought rather than massive support of those 'normal' and existing activities which may tend to perpetuate unsatisfactory educational practices and results."

Congressman Thomas was particularly interested in the question of how long it would be necessary to continue to improve course materials. The answer was that there would be a peak of activity in each of the disciplines, with some small updating effort. A list of projects was to be inserted in the record.

During the Senate Hearings on the FY 1965 budget, Senator Allot raised the issue of the use of education materials developed with NSF support. He was concerned that the support of curriculum projects by the government would force the use of these curricula. He does not want to have "these things rammed down the throats of educators." The response was that the techniques the NSF has adopted would not likely evolve in that way. Senator Allot also questioned the role of NSF cooperating with the Office of Education in developing a curriculum in Social Sciences. Senator Allot asked, "Is the National Science Foundation cooperating with the Office of Education in developing a curriculum in social sciences or in areas other than the natural sciences?" Dr. Riecken replied, "No, sir. We are not at the moment cooperating with the Office of Education on curriculum development in the social sciences." Senator Allot, "Are you working on curriculums in this area without the cooperation of the Office of Education?" Dr. Riecken, "We are supporting two projects—I think one by the American Anthropological Association and one by the American Sociological Association for the development of high school curriculum materials. There is no attempt to enforce the use of these materials in any school system." Senator Allot, "How will they be published and by whom?" Dr. Riecken, "At the present I'm not completely clear. In the past we have assisted publication in several different ways. A prime example of one way is the textbooks prepared by the Biological Sciences Curriculum Study which have just been published in three different versions."

Senator Allot later asked, "Can we get the answer clear then that they are not preparing a curriculum in the social sciences?" Dr. Riecken says, "We are assisting professional associations in preparing curriculum material which may or may not be adopted by the secondary schools. They are publicly available but not imposed on any school."

Hearings were held by the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, House of Representatives, in 1965 to review NSF. Included was a discussion of science education. These hearings were reported on in early 1966,[1] and were to be the basis for the 1968 amendments to the NSF Act of 1950. While there were no specific recommendations on science education, two pertinent observations were made, one dealing with teacher training, the other with support of new curricula. NSF was given credit for improving teacher training in the sciences; the issue was, could the job be done more effectively, NSF should learn more about possible methods. Credit was also given for progress in curricula improvement; the issue had to do with the apparent small number of professional groups involved. The thrust was for more competition in the field of curriculum development.

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[1] The National Science Foundation—Its Present and Future, Report of the Committee on Science and Astronautics, U.S. House of Representatives, 189th Congress. House Report No. 1236.

Early in 1965 the Committee on Science and Astronautics issued a report prepared for it by the NSF on *Science Education in the Schools of the United States*. This report traced the historical events and conditions that led to the status of science education at that time. It raised issues for public debate on such problems as "how much Science Education," improvement—a never ending task, investment in science education, and general scientific literacy.

The bill to amend the National Science Foundation Act of 1950 was discussed at Hearings before the Subcommitte on Science, Research and Development of the Committee on Science and Astronautics, House of Representatives, 89th Congress, Second Session, April 19, 1966.

The question of NSF's role in the social sciences was raised. Dr. Haworth in his testimony says, "Although the Foundation has for some years conducted limited but growing programs in support of certain aspects of the social sciences, it is widely felt that the time has come for these sciences to receive expanded attention from the Foundation, and it is fitting that the social sciences should now be recognized by that name in the Act itself rather than receive support anonymously as an "other science." He goes on to say that "this greater visibility should emphasize the efforts of the Foundation to stimulate and support increased research and improve education in the social sciences in order to help them play an increasingly important role in coping with some of the major problems facing society today."

The 1968 Amendments to the NSF Act of 1950 added the social sciences to the list of specific sciences the NSF is authorized and directed to support.

During the next several budget hearings, the Course Content Improvement Program was discussed. In FY 1966 budget hearings, Mr. Boland had commented that the appropriations subcommittee has encouraged NSF to work at the lower grade levels. Mr. Jonas asked, "You will run into trouble on social sciences with this won't you?" Dr. Riecken replied, "The kind of social science materials being produced under our grants are not, I think, likely to be as much trouble as the biologists have had over evolution." Mr. Jonas, "The leading article on the front page of the *Wall Street Journal* this morning indicates a little trouble brewing in that field right now on account of some revisions of social science textbooks." Mr. Boland, "On the social sciences the material you are preparing. . .wouldn't produce a lot of controversy, isn't that so?" Dr. Riecken, "That is right." Mr. Jonas inserted material from the budget document showing the request for elementary and junior high school studies and secondary school studies including material in the social sciences.

In the FY 1967 hearings, the National Science Board guidelines were discussed as were the mechanics and techniques of Course Content Improvement. The NSF point was that it did not permit Federal funds to be used for promotional purposes, and commercial versions of the material had to be competitive with others in the market.

In the discussion of the FY 1968 budget for the Cooperative College-School Science Program, Congressman Talcott asked, "Is this an effort to direct the thought of these teachers or control the philosophy of the teachers?" Dr. Fontaine responded, "No, not in any way." He went on to say that, "The school system is the one that makes the decisions and the Foundation assists the college or university to work with the school systems in the introduction of the materials that the school system wishes to introduce." Mr. Evins stated, "There has been a lot of concern to have the local people involved rather than having direction and dictation on the guidelines from the Office of Education." Mr. Boland, "You are making an effort to upgrade the quality of science on the local level by this cooperative program."

In discussing the course content improvement program, Mr. Talcott asked about principles of economics that are to be taught. Dr. Kelson responded, "The school system chooses the particular approach, presumably because it fits into the school's overall education program." Mr. Talcott asked, "You are not suggesting the philosophy or system of economics that is being taught or put into the textbook. This is a local option of the school district?" Dr. Kelson replied, "Yes."

The House of Representatives Report No. 259, 90th Congress on the Independent Offices and Department of Housing and Urban Development Appropriation Bill, 1968 carried a paragraph regarding the limitation language on supplementary education for high school math and science teachers (the institutes programs). It stated:

> —grants are awarded to teachers to enable them to obtain further proficiency in their designated fields. This has proven to be one of the most successful programs of the Foundation. The committee is not recommending the reduction as proposed in the budget, nor the change in emphasis that the budget suggests for the program. The committee on a number of occasions has earmarked funds in excess of the budget for this purpose and is of the opinion that a continuing need exists for these institutes.

The committee position was sustained in the appropriation act.

In the Authorization Hearings for FY 1970, in during discussions with Congressman Daddario on the training of teachers, NSF advised that it was placing more attention and stress on implementation, bringing the secondary school teachers into contact with new materials.

House of Representatives Report No. 91-288, 91st Congress, First Session, Authorizing Appropriations to the National Science Foundation, June 5, 1969, included references to science education in its explanation of the Bill. The report devoted fourteen pages to science education in general and specifically discusses the budget presentation program by program. There was mention that "an increasingly important aspect of the program is support for the training of resource personnel able to implement the new curriculums in local school systems." When discussing the Institutes activity, the report stated that "the projected program will stress the training of leadership through advanced studies and the implementation of local curricular improvement through training to teach the newly developed course content." It also spoke of efforts to improve school science curricula and discussed in detail the Cooperative College School Science Program and its efforts to focus on the improvement needs of local schools and school districts.

The report of the Committee on Labor and Public Welfare, United States Senate Report No. 91-285, 91st Congress, First Session, National Science Foundation Act Amendment of 1969 to Authorize Appropriations, July 2, 1969, discussed course content improvement and speaks of "implementation projects which have done much to alleviate the critical stress on the system of pre-college education." The report stated that it wishes to emphasize the importance it attaches to the Foundation's continuing to maintain effective coordination regarding its education programs with the Department of Health, Education, and Welfare.

In the NSF FY 1971 House Authorization Hearing, February 17, 1970, it was pointed out that curriculum development had been a powerful force for educational improvement. It was clear that the utilization of these resources would be neither widespread nor in many instances well done without judiciously placed assistance, both financial and professional. Therefore, about 1966, the Foundation initiated programs to help with the implementation of new courses, materials and methods. Mr. Daddario stated, "Give them the advice they need to develop the programs that would in fact truly fit their needs and this is the relationship you are talking about?" Dr. Fontaine replied, "Yes, and let me stress, the teachers would come not as individuals, but as participants with the full concurrence of the school system so that there would be a direct relationship between the purpose of the training and the needs of the school."

In testimony before the special subcommittee on the NSF of the Committee on Labor and Public Welfare, United States Senate, 91st Congress, Second Session on the NSF authorization for FY 1971, the Director, NSF was questioned by Senator Kennedy on social science teacher programs. The response was that social sciences were covered in the institute programs and effort was being devoted to the development of curriculum materials; about 10 percent of the science education budget contributed to social sciences. The differences in handling of history and social sciences was noted with the comment, "It is a difficult area for us to sort out, but we are trying to be as helpful as we can within what we consider our legislative mandate."

In House of Representatives Report No. 92-204, 92nd Congress, First Session Authorizing Appropriations to the National Science Foundation, May 17, 1971, there is a description of the emphasis being placed upon "relevant teaching programs and curricula (increasingly teacher institutes, especially for high school teachers are being related explicitly to the efforts of school systems to adopt new teaching programs which entail teacher restraining)." The report states that, "In substance the programs are being modified extensively to develop leadership personnel in the hope that there will be less need for Federal funds and professional assistance from outside the schools themselves."

The report also says that substantial effort is devoted to training teachers in the use of new materials and instructional programs, a type of activity essential in the effective implementation of curricula in the schools. Under the heading, Course and Curriculum Development and Implementation Activities, the report describes making available to schools innovative and improved teaching materials and techniques which local schools have neither the funds nor the scholarly expertise to generate themselves.

The report stated that the Committee is concerned about maintaining and increasing the quality of teaching and research at all levels rather than the quantity of new scientists being produced. In speaking to the precollege level institutes, the report states that "the NSF can more effectively introduce revised curricula at the precollege level since new courses and revised teaching methods are no better than the trained personnel charged with implementing them.

The Senate report No. 92-232, 92nd Congress, 1st session on the FY 1972 authorization made a substantial increase over the NSF budget amount for Science Education support. The action was taken based on the stated belief that "these programs have had a very beneficial impact on the quality of science education in the United States." The action taken is "considered necessary to provide for the maintenance of quality science education in the United States." Among the programs cited were pre-college teacher institutes and development of new course material, courses, and curricula for use at all levels.

The committee went on to state it believed there would be, over the long term, increased demand for science and engineering professionals; it would not be "in the best interest of the Nation to make precipitous reductions in science education and institutional science support programs of NSF in order to compensate for short-term fluctuations in the employment market."

In the House Appropriations Hearings as in the House Authorization Committee Hearings, Dr. McElroy had spoken to the need to develop new introductory courses in science organized around societal problems rather than by traditional disciplinary approaches. He also spoke of the program for implementation of curriculum development projects. In the discussion of the education programs, Dr. McElroy discussed with Congressman Giaimo the fact that in terms of innovative curricula NSF had not deemphasized that activity nor the development of the personnel to carry out those curricula.

The House of Representatives Report 92-305, 92nd Congress, 1st Session, on the FY 1972 appropriation bill referred to Science Education Support with the comment that the committee expects that funds included for that purpose will not be diverted to other purposes. The Senate Report (No. 92-264) voted a not-less-than amount for science education support.

House of Representatives Report No. 91-1060, 91st Congress, Second Session, Independent Offices and Department of Housing and Urban Development Appropriation Bill, 1971, May 7, 1970, made a reference to programs ". . .updating the subject matter and instructional competence of teachers. The Summer Institutes Program has been particularly useful in disseminating new ideas to a broad base of teachers that are immediately used in teaching students throughout the country." Senate Report No. 91-949, 91st Congress, Second Session, Independent Offices and Department of Housing and Urban Development Appropriation Bill, 1971, June 24, 1970, speaks only of earmarking funds for Summer Institutes. They (the Senate) prefer instead to "leave the funding of programs to the better judgment of the Director and his assistants."

During the hearings before the Committee on Science and Astronautics and the Subcommittee on Science, Research, and Development, House of Representatives, 92nd Congress, First Session, on the FY 1972 authorization, Dr. Herbert Carter, Chairman of the National Science Board, made reference to graduate education in the sciences and was questioned by Mr. Mosher on his "limited emphasis." Dr. Carter responded, "The health of science in this country cannot be maintained without the general support and proper education for all levels." Congressman Mosher agreed and went on to observe that we have to start with the primary grades and establish a solid base.

At a second hearing, March 23, 1971, in his opening statement, Dr. McElroy noted that the education program teacher institutes would be designed to concentrate specifically upon individual school system requirements. In a discussion of criteria for determining priorities in the science education programs, Dr. Humphreys told Congressman Davis that one of the options that the Foundation had provided for in its FY 1972 budget was the development of introductory courses in science that are organized around social problems rather than by the traditional disciplinary approach. Dr. Humphreys' prepared statement discussed the pre-college level curriculum development and implementation activities and specifically mentions: *Man: A Course of Study*. He also discussed the future use of institutes as a mechanism for involving curriculum supervisors, principals, etc., in the implementation process.

At the NSF FY 1973 House Authorization Hearings the Director's opening statement stated, "We will continue to support teacher training projects in an attempt to build a capability for improving science programs at the pre-college level by training key personnel in the management techniques and mechanics of introducing new course materials." The Instructional Improvement Implementation Program designed to aid in the implementation of new curriculum materials in elementary and secondary school classrooms was discussed in detail.

In the FY 1973 House Appropriations Hearings during the discussion of the science education program between Congressman Talcott and Dr. Kelson there was an explanation of the need to train teachers in handling the new curricula that are now being installed in the elementary and secondary school classrooms. In the discussion of the science education improvement program, Dr. Kelson stated that, "We have found that once you have supported the research and development of new programs such as the curriculum and the new way of teaching science education, the use of these programs doesn't just happen all on its own. Therefore, the second part of our program is to help the school system to actually put into practice these new approaches to instruction." Congressman Giaimo discussed development and implementation and the fact that it does not duplicate HEW interests.

At the Senate Appropriations Hearings for that same year, Dr. Stever in his prepared statement stated that, "We plan to train key personnel including administrators and teachers, not only in subject matter but also in techniques of handling new science course materials which are of direct interest to them." In materials submitted for the record, it was stated that explicit programs for implementation are also necessary and that the Foundation's program of Instructional Improvement Implementation attempts to foster and promote the implementation of eduction reform.

Other than descriptive material on the program there were no comments regarding the pre-college science education program in the reports from all the committees.

In the FY 1974 House Authorization Hearings, the curriculum development activities under Careers and under Science Literacy were described. Most of the discussion during these hearings, however, was on the level of support for science education improvement requested by the Administration rather than the programmatic efforts themselves.

In the House Appropriation Hearings for FY 1974 the section of the budget document covering Science Education Improvement was inserted in the record. Concerning this material, Congressman Roush asked about the summer institutes program and Dr. Kelson noted that the Foundation will be devoting relatively more attention to helping teachers effectively use the new teaching programs. Congressman Roush inquired into the redirection of the Science Education Improvement program and the discussion revolved around the role of OMB in this redirection.

In the House of Representatives Report No. 93-284, 93rd Congress, First Session, Authorizing Appropriations to the National Science Foundation, June 14, 1973, the science education improvement program was explained. This was the first year that the breakout between Careers, Literacy, Effectiveness, and Problem Assessment was used. The implementation of new courses and materials was discussed. The Committee discussed the selective withholding carried out in the prior fiscal year by the Administration. The Committee restated its strong interest in the program of science education and emphasized NSF's responsibility for science education under its Organic Act of 1950.

The Senate Report No. 93-275, 93rd Congress, First Session, National Science Foundation Authorization Act of 1974, June 28, 1973, stated that the Foundation's request for science education improvement was inadequate but makes no more detailed comment.

At the FY 1975 NSF House Authorization Hearings, the implementation of newer curriculum materials is stated to be as important as the original development. The Foundation will continue to seek effective ways to help school administrators, teachers, and school systems with this problem.

At the FY 1975 Appropriations Hearings it was noted that the Foundation was concerned in that the new curriculum materials were not being implemented and that therefore the teacher training activities were being reoriented to assist in the adaptation and adoption of curriculum materials.

The House of Representatives Report No. 93-995, 93rd Congress, Second Session, Authorizing Appropriations to the National Science Foundation, April 15, 1974, in Committee Views, mentions science education with a rationale for increasing the amount requested by the Administration but there were no comments pertinent to pre-college activity.

Senate Report No. 93-848, 93rd Congress, Second Session, National Science Foundation Authorization Act of 1975, May 15, 1974, urged two efforts in science education improvement: (1) ethnic minorities and women and (2) strong support for programs designed to improve the quality and effectiveness of science teachers at the elementary and secondary school levels. The Committee stated that "the Foundation should take the necessary steps to reestablish and maintain Summer Institutes specifically designed to enhance the subject matter competence of teachers."

> The Committee does not agree with the position taken by the Foundation that Summer Institutes aimed at upgrading the science subject matter proficiency of teachers can now be phased out.

As can be seen, interaction between NSF and the Congress was mainly in an authorization and budget context. Much of the material contained in the hearings has been taken from annual budget documents or has been additional material prepared by the NSF in response to requests from the committees. The pre-college science education activities have been supported as demonstrated by the general acceptance of budget levels and in some instances by specific limitations and budget increases. Many areas of concern were discussed over the years. Advice and guidance from individual members of Congress and in the official reports of committees attest to a continuing keen interest in ensuring that an effective and appropriate effort is carried out in pre-college science education.

Overview of Present Practices

INTRODUCTION

The National Science Foundation currently supports a variety of activities for improving education in science, mathematics and social science. At the elementary and secondary school levels the Foundation's activities are now oriented towards two general goals: 1) the development of science literacy, that is, improving the capacity of children to understand the concepts and applications of science and their implications; and 2) the improvement of education for those likely to choose careers in science. The current set of activities has evolved over a period ofyears as the science education environment changed, as the national perception of needs for scientists and engineers was revised, and as it became clearer that an understanding of science and technology by all citizens was crucial to the economic, social and political processes of the nation.

Changes made in NSF curriculum development and implementation programs during the late 1960's and early 1970's, particularly with respect to what critics call "marketing" or "promotion" of curricula developed with NSF support, reflected the guidance of the Executive Office of the President. While NSF support for basic and applied research was substantially increased, the NSF Institutional Development programs were phased out and science education programs decreased in level and revised in content. The important theme during this period was the need to increase effectiveness.

Table 5
SUPPORT OF EDUCATION IN THE SCIENCES, FY 1958-FY 1974

Obligations by Fiscal Year
($000)

	Program Category	FY 1958	FY 1959	1960	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966	FY 1967	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973	FY 1974
1.	Fellowships & Traineeships	$5,602	$13,071	$13,391	$13,119	$16,800	$21,678	$30,105	$40,224	$44,485	$45,874	$46,057	$39,811	$43,147	$34,407	$20,340	$15,308	$12,999
2.	Institutes - Pre-College Teachers	12,212	33,248	33,775	34,500	40,876	41,804	43,247	43,196	40,531	37,929	38,328	34,713	39,866	24,525	23,373	15,126	17,143
3.	Cooperative College-School Science Programs	—0—	—0—	—0—	—0—	521	751	721	848	1,957	2,213	3,387	4,823	4,654	4,730	4,355	2,020	
4.	Science Activities for College/University Teachers	166	2,381	2,348	2,647	2,374	2,559	3,714	4,004	2,983	3,890	3,096	797	1,230	4,577	3,182	3,823	3,711
5.	Undergraduate Student Programs	—0—	1,692	2,871	3,388	4,373	5,878	6,052	5,479	6,583	4,734	4,142	3,716	3,817	5,418	5,757	3,228	3,755
6.	Secondary School Student Programs	389	4,843	4,458	3,050	2,898	2,932	3,198	2,554	1,973	2,070	2,067	1,885	1,931	2,051	1,938	1,955	1,375
7.	Course Content Improvement Programs	835	6,030	6,299	6,411	8,990	12,632	13,976	14,552	15,564	18,355	19,352	12,440	[3]9,840	10,314	10,898	3,311	8,281
8.	Equipment for Undergraduate Instruction	—0—	—0—	—0—	—0—	5,019	7,734	8,650	8,205	7,736	4,906	4,336	4,498	4,367	—0—	2,881	1,578	3,140
9.	Special Advanced Science Education	—0—	25	317	327	1,406	2,753	1,568	[1]1,353	—0—	—0—	—0—	1,309	1,296	3,521	2,255	3,365	8,570
10.	Special Projects	—0—	—0—	—0—	—0—	—0—	—0—	—0—	[2]—0—	2,494	3,388	2,808	1,817	2,210	1,469	—0—	—0—	—0—
11.	Pre-Service Teacher Education	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	370	679	993	2,635	1,510	367	1,570
12.	College Science Improvement Program	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	2,464	9,624	8,764	6,829	5,165	9,067	5,129	8,472
13.	Computer Innovation in Education	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	[4]8,372	8,216	7,432
14.	Research & Problem Assessment	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	—0—	2,059
		$19,204	$61,290	$63,459	$63,442	$83,257	$98,721	$111,231	$120,415	$124,305	$125,824	$134,456	$115,297	$120,180	$98,812	$93,728	$61,426	$78,497

[1] Carried under Item 4.

[2] Formerly carried under Item 4.

[3] Includes Tech. Ed.

[4] Carried under Computing Activities prior to FY 1974 budget submission.

Source: *NSF Justification of Estimate of Appropriations: The Congress*, Fiscal Years 1960 through 1976. Totals may not add due to rounding.

The pressure for revision is indicated by the budget levels which dropped from $120 million in FY 1970 to $61 million in FY 1973. (See table 5). Increases made in support for fellowships and traineeships were opposed by both the National Science Board and the Congress. Similar cuts made in support for training institutes for pre-college teachers were also opposed by the Congress.

Table I (items 2 & 3) shows the level of NSF involvement in large scale pre-college teacher training activities since the late 1950's. While the earliest institutes emphasized subject matter training, later ones included aspects of pedagogical techniques and familiarization with new courses. By 1970 training for new instructional programs as well as implementation of these programs were included as program activities to be supported.

After FY 1970 funds for teacher training activities were substantially reduced from about $40 million to about $17 million in fiscal years 1973 and 1974. Concurrent with this reduction, emphasis was placed on training for implementation of new courses and then mainly on the implementation of courses which might have widespread impact, such as those developed with NSF support. Thus in 1975 over 80 percent of such activities are aimed at getting courses and materials developed with NSF support into use in the schools. This is a reversal of the situation two or three years before when less than 30 percent of the implementation activities involved such courses.

This change was not construed as a massive implementation or marketing program, since only a fraction of a per cent of U.S. schools could be reached in any year due to the large size of pre-college education in the U.S., since the training programs were designed by the grantee, and since the institutes include many non-NSF courses.

NSF's initial FY 1972 budget request to the Office of Management and Budget (OMB) of $33.3 million for high school teachers was cut to $17.0. Course Content Improvement for elementary and secondary schools, the program for development of new courses, was uncut ($11.2 million). The NSF Director then requested an increase in "Institutes" to $23.3 million. This increase was allowed by OMB with the stipulation that NSF introduce new criteria for selection of participants in the program. Such criteria should require the teachers' school systems to assist the teachers in introducing the material derived from the Institutes into their instruction programs, and help improve the effectiveness of this program. This was explained in the NSF FY 1972 Budget to Congress as follows:

> Finally, many institute projects will be directly related to the new curricula and course material interests of school systems. Teacher participation in these projects will be contingent on the endorsement of the teacher's institution to insure that there will be maximum opportunity for introducing improved science instruction programs in the school.

General guidelines suggested by OMB were to reduce the emphasis on support of individuals and increase emphasis on educational innovation and productivity. The NSF response was stated in the introduction to "Summer Institutes for Secondary School Teachers of Science and Mathematics, 1972" as included in the Summer Institutes Directory issued in December 1971.

> Many secondary schools and school systems have begun to implement important changes in their science or mathematics programs or are seriously considering doing so. The principal objective of the National Science Foundation's Summer Institutes for Secondary School Teachers is that of providing to teachers in such schools training and information which will enable them to help their schools, to the maximum extent possible, effect those constructive changes. Therefore applicants to an institute will be expected to indicate explicitly how their participation would relate to educational developments in their schools, and that statement must be endorsed by a local school authority. It should be noted that this constitutes a significant departure from the earlier NSF Summer Institute program objective of up-dating the subject-matter knowledge of teachers as individual professionals.

The OMB guidance resulted in a study to develop objectives, criteria, specific programs, cost estimates, etc. The resulting report was a major effort involving interaction with both OMB and the Office of Science and Technology. It covered six main topics: Problems, Roadblocks, Federal and NSF Roles, Criteria (for program), NSF Objectives, and Proposed NSF Programs.

Issues raised in this report concerning plans for curriculum included:

- The strategy for developing new or innovative curricula, e.g. will the emphasis on local curriculum development for higher education programs be continued or will an effort be made to develop curricula for application nationally?

- action to be taken to encourage the publishing industry to support major curriculum development projects;
- redirection of Teacher Institutes to help accomplish broader program goals, such as innovative curricula, changing the institutional arrangements or improving productivity.

OMB indicated that additional detailed planning was needed prior to final apportionment of funds, but approved the overall thrust of the presentation for inclusion in the President's budget.

Prior to formulating the FY 1974 budget an NSF/OST Task Force Study of NSF education programs was undertaken. Though a formal report was not issued the draft Working Paper was, as intended, an important input into the FY 1974 Budget.

The report recommended a shift in emphasis from science education to prepare research scientists to science education to prepare students for the wider range of occupations that demand a scientific or technical background and to increase the science literacy of the population as a whole.

The report's recommendations on NSF-supported teacher activities resulted in large part from consciousness of high and increasing costs of education. The only teacher training activities recommended in the report are those associated with implementation of the course materials to be developed.

The FY 1974 Budget to the Congress stated:

> Personnel reorientation and school implementation not directly related to new approaches developed with Foundation support will be eliminated, except that activities involving materials developed through mechanisms other than NSF sponsored efforts may be supported provided that thorough evaluation of the effectiveness of the materials is available and clearly demonstrates that they can make a significant contribution to the attainment of the program activities.

The substantial revisions of the NSF Education programs were explained to the Congress in connection with the FY 1972-1974 budgets. The emphasis on use of teacher training, short courses for supervisors, and for implementation of new course materials was one of a number of changes and was presented in the formal budget documents, mentioned in statements and discussed particularly with the House subcommittees, as the official NSF position.

As demonstrated the concerns for increasing impact and effectiveness and controlling costs by the Executive Office of the President led to significant changes in the program. The relating of teacher training and similar activities to implementation of new courses, particularly those developed with NSF support, was only one of these.

The problems faced by any program in strengthening science education at the pre-college level are evident by the fact that 1) There are some 50 million students in grades kindergarten through twelve, ranging in ages from 5 to 18 years with rural, suburban, and innercity backgrounds. Not all are science oriented, nor are all college bound. 2) There are 1.3 million elementary school teachers and 400,000 secondary school science teachers. 3) Credentials vary from state to state. There are some 17,000 school districts with close to 2 million classrooms; and there are many, many varieties of State or government control.

Since students in elementary grades rarely make career choices at that level, and it would be unrealistic to speak of science-oriented students in these grades, course materials, curricula and instructional strategies must be directed at *all* students. There are multi-year curricula; there are attempts to unify science and mathematics; adoption practices for materials vary between State and local school options; and there are many intricate relationships between local school boards, district science supervisors, State boards of education, and Federally prescribed State commissions. It has become apparent that materials and instructional strategies appear to be the best leverage points to be used in pre-college science education. There are, therefore, two principal aspects of the current pre-college education in science programs: (1) materials development, testing and evaluation; and (2) instructional improvement implementation.

Materials and Instructional Development

The objectives of this program as stated in a recent *Guide for Preparation of Proposals and Project Operation* are to encourage

scientists and science educators to carry out projects for the improvement of pre-college education in mathematics, the sciences, and social sciences. The initiative for undertaking projects should arise from a recognition on the part of scientists and educators that a non-trivial problem exists with respect to education in scientific disciplines or a curriculum area with an important component of science content, and a willingness to help solve the problem. An essential condition of any such undertaking is a substantial commitment of time and effort by scientists distinguished as teachers and investigators in the disciplines (or problem areas) concerned.

The program is concerned with projects that are designed for a broad ability range of students not only those oriented toward science careers; interdisciplinary in nature, particularly those that involve the social sciences; relate science and technology to environmental and societal problems; involve application of innovative educational technologies; and projects that involve experimentation with new structures and procedures in science education. The model process followed to carry out these efforts is shown schematically in fig 1. An individual proposal may not follow exactly the sequence shown.

The first planned step in the development of a project is a needs identification and assessment. A need for a Materials and Instruction Development Project may be identified in one of three ways: First, based upon a literature search or other survey not sponsored or supported by NSF, an unsolicited proposal may be submitted to undertake a materials and instruction development. Included in this proposal would be an identification of needs and an assessment of those needs. In this sense, the formal need or problem assessment step is not undertaken; Second, the Foundation may receive a proposal to hold one or more conferences to specifically assess a perceived need. Support may be requested solely from NSF or from NSF and other agencies. NSF staff may or may not participate in the conference, and NSF may or may not be requested to suggest attendees. The conferences may have been suggested by NSF or may be the result of an unsolicited proposal; Third, NSF may formally suggest an area for study and call for proposals. NSF requires that attendance at these conferences include a diverse group of participants from a particular scientific discipline, science education community, science education developers, and user communities, both administrative and teaching. A report is required which would make recommendations as how to respond to the particular need if a need was identified. Reports are to be disseminated, both selectively and in journals within the education and appropriate discipline-oriented communities. The conferences may recommend supplementing existing techniques or developing new ones; they may suggest new instructional strategies, or they may recommend development of complete new curricula.

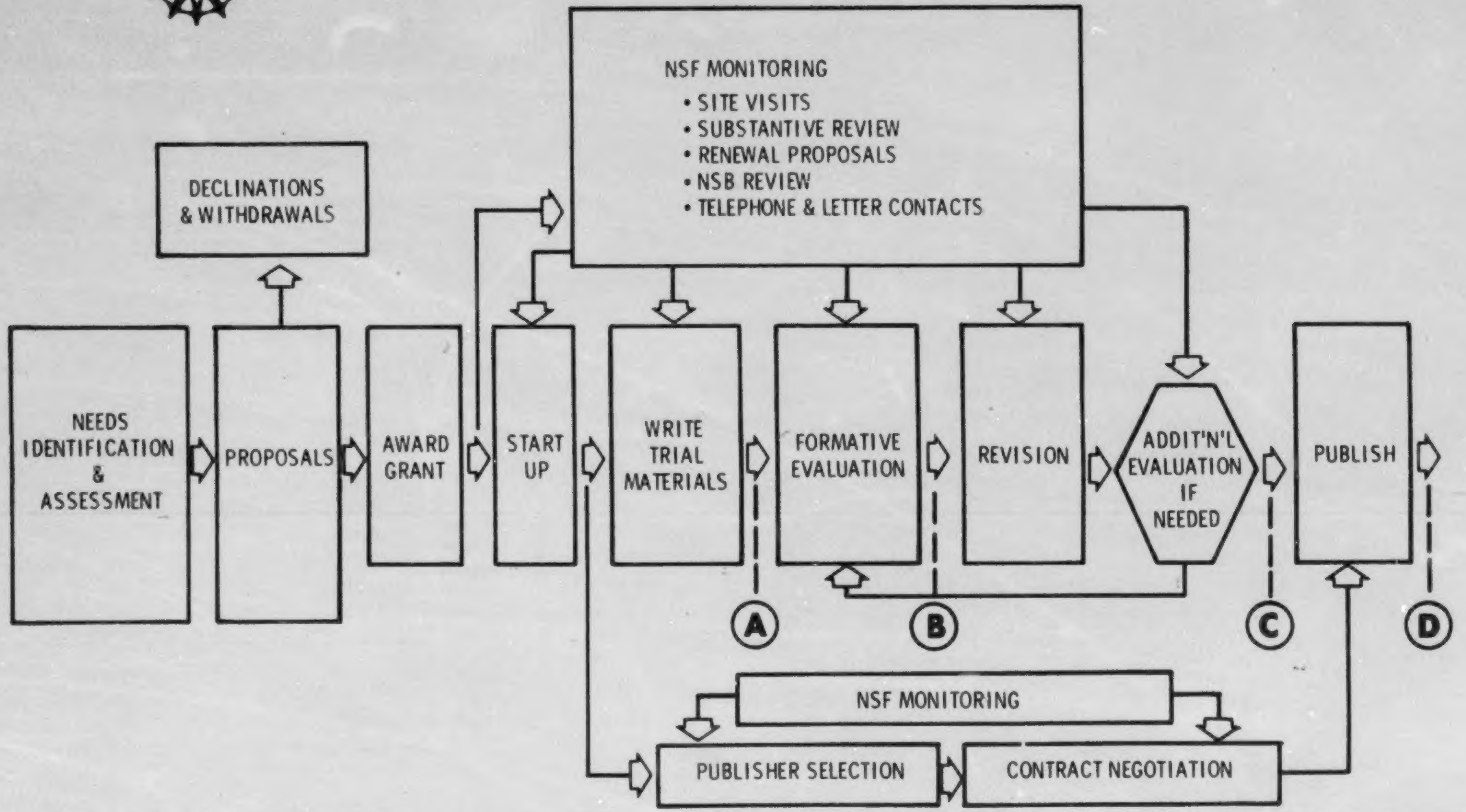
The Foundation *Guide for Preparation of Proposals and Project Operation for Materials and Instruction Development* outlines the categories the Foundation will consider for the establishment of projects. It defines the scope, the eligible organizations and the eligible fields for which proposals will be accepted. This document is not considered a solicitation, but is a public indication of areas of interest to NSF. Proposals received by NSF are generally unsolicited, although there may be some instances of solicited proposals. Participants in a needs conference may and usually do submit a proposal. (Usually, a conference participant who submits a proposal has a better chance of success than a non-participant.)

The proposals are generally based upon available needs assessments, either developed through the conference mechanism or through other sources. They are reviewed by NSF staff and by outside reviewers. Site visits by both staff and outside reviewers may be carried out. In reviewing proposals, among the criteria used, are the likelihood of the impact on the community of a successful development and consideration of non-NSF sources as potential sponsors. These are in addition to the normal criteria of scientific merit, the competence of investigators, and others. The program staff also develops a priority ranking for a proposal.

Outside reviewers are used extensively. The intent is to obtain a representative spread of interest, so that for any particular proposal there may be a mix of curricular developer, science educator, discipline-oriented reviewer, teacher or administrator at school level as a participant in the review process. There may be from six to twelve reviewers on each proposal. While geographical distribution is considered in the overall group of reveiwers for all proposals, it is not a criteron for the selection of reviewers for individual proposals.

Upon receipt of comments from reviewers the program staff assesses the reviews and their im-

MODEL FOR MATERIALS AND INSTRUCTION DEVELOPMENT



NSF MONITORING
- SITE VISITS
- SUBSTANTIVE REVIEW
- RENEWAL PROPOSALS
- NSB REVIEW
- TELEPHONE & LETTER CONTACTS

DECLINATIONS & WITHDRAWALS

NEEDS IDENTIFICATION & ASSESSMENT

PROPOSALS

AWARD GRANT

START UP

WRITE TRIAL MATERIALS

FORMATIVE EVALUATION

REVISION

ADDIT'N'L EVALUATION IF NEEDED

PUBLISH

A

B

C

D

NSF MONITORING

PUBLISHER SELECTION

CONTRACT NEGOTIATION

IMPLEMENTATION PHASES:

Ⓐ PROJECT INFORMATION (NEWSLETTERS, PROFESSIONAL SOCIETY PRESENTATIONS)

Ⓑ EARLY IMPLEMENTATION BEGINS

Ⓒ FULL SCALE IMPLEMENTATION

Ⓓ LATE IMPLEMENTATION

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pact on a proposal. Where appropriate they relay back to the proposal writer a paraphrasing of reviewer comments, particularly in those cases where changes may be made in a proposal which has potential for success. In other instances, they may reject the review after careful consideration of the background of the reviewer, misunderstanding of the proposal or the significance of the review. After staff determinations of priority, and a tentative decision to make an award, the level of effort and a budget for the proposal are then negotiated.

During this process, proposals may be withdrawn by the proposer and in many instances where it is clear that the proposal will be denied, the proposer is offered the opportunity to withdraw. (There is a general belief that denial of a proposal will be detrimental to the chances of success with future proposals.) Proposals that are denied are signed off at the division director level. Approvals require the signature of the Assistant Director for Education.

Upon approval, the project director undertakes a formal selection process to develop his project staff team (NSF may advise on the staff) and to establish his business procedures. Although it is not usually a requirement of the grant, an advisory board is established. NSF exercises oversight of membership of this board. Since all development projects require a demonstration, selection of a trial center or centers is made. With the advisory board in place, the objectives of the project are sharpened, topics are redefined as necessary, and the pedagogical approach and wirters are selected. NSF may advise in almost any of these phases.

The next general phase is writing. With the topics selected, the writing teams produce and revise materials until they are adequate to try in classroom. Revisions made after trial may use student guidance as a formulation mechanism.

In the formative evaluation phase, a pretest is administered, if appropriate, with test materials used in a classroom. Both the project staff and NSF may have oversight. After the pretest is administered the project staff analyzes and evaluates the results to determine whether or not revisions are needed. If they are, the cycle is repeated. If they are not, then the project is ready for publishing.

If revision is necessary, writers (not necessarily the primary authors) revise the material in response to the formative evaluation results. A decision is then made whether additional formative evaluation is needed. NSF then enters into the process. If it is needed, the previous steps are followed. Completion of the revision then leads to the publication phase.

Although schematically the publication phase would appear to begin at the end of the revision sequence, appropriate publication arrangements can be made at any point in the cycle. The developer submits to NSF proposed procedures for notifying potential publishers of the availability and nature of the materials. The Foundation has the responsibility for approving or disapproving these procedures. The developer proceeds to the point of receiving and evaluating proposals from publishers and makes a tentative selection of a publisher. The Foundation is then asked to either approve or disapprove. The grantee and the publisher with NSF consultation negotiate a publication contract. Again the Foundation has the right to approve or disapprove. The contact is signed between the developer and the publisher. Although NSF has participated in the development of the contract, it is not a party to the contract. In the event equipment is required, similar arrangements are made either on a contract or subcontract basis between the developer and a manufacturer.

It should be noted that during this entire process the NSF staff has certain responsibilities for monitoring the program. The program manager should make site visits, should be in constant contact with the developer, may use consultants to review efforts and, depending upon the nature of the project, progress reports may be issued. Due to the difficulties in obtaining staff time, site visits may be scheduled to a developer depending upon the size of the project only every 12-18 months. Substantive reviews are generally carried out only when additional funds are to be allocated to the development project. Since many of these projects are of major size, they may be referred to the National Science Board for review and approval.

The Secondary School Program in the budget element Increasing Effectiveness of Educational Processes is directed toward providing secondary school students the best possible foundation for science or technology related careers. The objectives include development of course materials attractive to a significant fraction of the enrollment and fostering the acquisition of problem-solving skills rather than providing training for specific jobs. For those students who plan to go to college, support is provided for the development of course materials which present alternatives to conventional discipline-oriented curricula to be presented in flexible format appropriate for individualized study. A major effort under way is the Individualized Science Instructional System—a sequenced, multidisciplinary course for grades 10 through 12, organized around topics of intrinsic student interests. It consists of highly flexible, independent modules, each requiring two or three weeks of classroom time.

Work is progressing on a medical interdisciplinary curriculum project for 11th and 12th grade students preparing for careers in the health fields, and resource and teacher centers are planned to aid in the dissemination and implementation of new mathematics and science materials. Under way also are some junior high level mathematics projects which provide alternatives to current mathematics programs and are aimed specifically at applications in mathematics to science and technology.

In the secondary school student component of the Student Originated Projects, the Foundation plans to supplement, wherever possible, local or regional resources, and, by the use of Federal funds, to extend to more students special opportunities for independent study in science. It is expected that about 105 projects involving some 4,500 students at more than 3,500 high schools will be undertaken during FY 1976, and some money will be used to continue experimentation with a variety of projects designed to test ways to introduce project-centered instruction in the high school setting.

The elementary school program included in the Improvement of Education for Science Literacy Budget is designed to introduce into the school expertly-developed and tested classroom activities which will stimulate the interest of elementary school students in science and mathematics. The two principal components of program support are (1) development and testing of materials and instructional strategies attractive to young children which will encourage learning and which will increase their basic knowledge, and (2) systematic implementation efforts to assure that the materials which have been developed are used effectively in the classroom.

Two development projects in mathematics stemming from a series of study conferences on the status of mathematics curricula in schools are currently evolving slowly with considerable attention being paid to research results in mathematics learning. There has been a comprehensive analysis of mathematics achievements results initiated by the Conference Board of the Mathematical Sciences. There is encouragement of locally-supported inservice orientation of teachers in content and instructional strategies for new science and mathematics materials.

Assessment and evaluation of barriers to the implementation of course materials and the accumulation of data on the usage of NSF-supported materials is under way. Planned projects include an interdisciplinary (mathematics/science) problem-oriented course which requires active participation by students, research in the learning of mathematics concepts and skills, studies of the impact of newly-developed curriculum materials in classroom situations, and the development of materials and strategies for alternative patterns of education.

The Secondary School Program will test teaching materials and strategies, assist in the dissemination of information about newly developed curricula to decisionmakers at the State and local levels, assist colleges and universities to participate with school systems in cooperative implementation projects and broaden the base of individuals other than curriculum developers having skills needed in the implementation of specific materials. Efforts such as the development of a modularized, multidisciplinary high school science curriculum and related teaching materials, a sequential interdisciplinary human science course for the middle grades, and an interdisciplinary political science based curriculum, and materials and strategies for alternative patterns of education will be continued.

A new junior high level mathematics course and supplementary materials for use in existing courses on energy-related topics and recent findings on the structure and dynamics of the earth's surfaces is to be started in FY 1976.

Instructional Improvement Implementation Practices

The development of curricula materials is not in itself sufficient to assure utilization. Creators of new educational materials generally begin to provide information about their activities to engender an awareness of product availability as part of the development process and in preparation for field testing shortly after they have proceeded to write trial materials. Information may be provided in terms of newsletters, professional society presentations, and other ways; it is necessary to development and is a preliminary step to implementation. Implementation will include dissemination of information to school system decisionmakers about new and recently released curriculum projects; development of resource personnel among leaders with responsibility for initiating in-service education; orientation of influential teachers in new materials; and intensive implementation of new materials in a significant number of classrooms within a school system by cooperative projects with near-by colleges or universities.

Early implementation may begin shortly after the formative evaluation. This is particularly true where there is field testing and trial use of materials. Full scale implementation will begin just about the same time that the decision is made to publish; late implementation may take place after the materials are available in published form, and new users as identified.

Through its *Guide for Preparation of Proposals and Operations of Projects for Instructional Improvement Implementation Grants*, The Foundation invites proposals for projects designed to implement major curriculum and course developments at the pre-college level. The implementation process encompases dissemination of information about, and adoption of new educational materials and techniques. Implementation activities vary.

A first stage of the process is to create awareness, that is, to disseminate information about materials to curriculum decisionmakers; conferences are the usual method. This may be followed by activities designed to develop an interest in the materials by training of resource personnel. Utilization and trial on a preliminary basis permits potential users to examine the characteristics of the materials and for individual teachers to become familiar with it. With school systems' adoption, implementation activities then focus on orientation for key teachers who are to use the materials with a critical number of students.

Administratively, implementation projects are grouped into three categories: (1) *Leadership specialist projects* - designed for specialized educational personnel such as master teachers, department heads, principals, supervisors, college faculty, State Department of education staff members, superintendents, curriculum directors, and others who influence curriculum decisions and lead implementation efforts. These leadership projects assume a variety of forms. Some are designed primarily as information conferences to acquaint school administrators with one or more of the new curricula, their characteristics and costs in order to provide a basis for informed decisionmaking. Others provide an opportunity for study of specific curricula and prepare participants to assist their colleagues and other educators in installing these curricula in their schools.

Grants in support of the leadership specialist projects provide funds to cover instructional costs and assist participants in meeting expenses associated with their participation, such as room, board and travel. The participant funds represent a contribution toward enabling individuals to take part in a project, and these funds may or may not cover the full cost of participation.

2) *Teacher projects* - designed to bring about classroom change or improvement through effective teacher utilization of new instructional materials or practices. Because of the large number of elementary teachers (1.3 million) proposals for elementary teacher projects must have the promise of large impact potential due to built-in multiplier factors for provision of instruction to a large number of teachers at low cost such as through the application of educational technology. Elementary and secondary projects are designed to prepare teacher participants to teach new curricula materials effectively and to be able to assist their colleagues and other educators in introducing new curricular materials into their classrooms. Projects assume a variety of formats. Many have a summer phase lasting from two to eight weeks. There are follow-up meetings during the subsequent school year. A few projects are conducted solely during the academic year. Funds are provided to cover instructional costs and to assist participants in

meeting expenses associated with their participation, such as room, board and travel.

3) *school system projects* - directed at bringing about specified curriculum or course changes or improvements in classrooms through the direct cooperation of colleges and universities and/or school systems willing to commit funds, personnel and other resources in effecting these changes. Here the expectation is that a school system will have committed itself to the improvement, but needs help in bringing it into their school system.

System project plans may vary and include elements found in leadership specialist or teacher-centered projects. Typically, the plan requires a commitment of the school system and associated colleges to utilize specific national curricula, summer and/or academic year training in requisite subject matter and appropriate teaching techniques, marshalling of resources from within and beyond the schools that will guarantee unsuccessful implementation, and development of leadership and allocation of resources to assure continued expansion and maintenance of the program beyond the funding period.

Funds will be provided to cover instructional costs and to assist participants in meeting expenses associated with their participation. Design of school system projects requires a detail plan involving funds, personnel, materials or other resources that will guarantee effective utilization of the national curricula in a classroom targeted for implementation.

Proposals are generally submitted on an unsolicited basis to this program. Guidelines are provided as mentioned earlier. These guidelines have been distributed to all school systems with an enrollment of over 10,000, supervisors of mathematics, science and social science listed in the U.S. Registry of junior and senior high school teaching personnel, directors of current projects, individuals whose proposals were denied in earlier competitions, and individuals who have asked that guidelines be sent to them. The program utilizes a peer review system for the determination of proposal merit.

An ad hoc panel to review these proposals is used with a large number of panelists (about 185 in Fy 75). Panelists are selected from scientists, science educators, knowledgeable classroom teachers and school system administrators. Consideration is given in the selection of reviewers to their geographical or institutional representation, their experience, the content of the proposals as related to panelist background, and prior experience (or its lack) in the review process. An attempt is made to match panelist's qualifications to proposal content. Each proposal is read by two panels of six individuals with the expectation that panelists would provide comments of a helpful nature in addition to rating the proposal. The proposals are also reviewed by staff. As highly meritorious proposals are identified they are immediately negotiated barring the existence of any specific problem. Lower ranking proposals are discussed among the staff. These frequently require substantive negotiation to improve the proposal before award is recommended.

Upon recommendation of a grant and the approval of the Assistant Director for Education awards are made and a directory is prepared listing all approved projects.

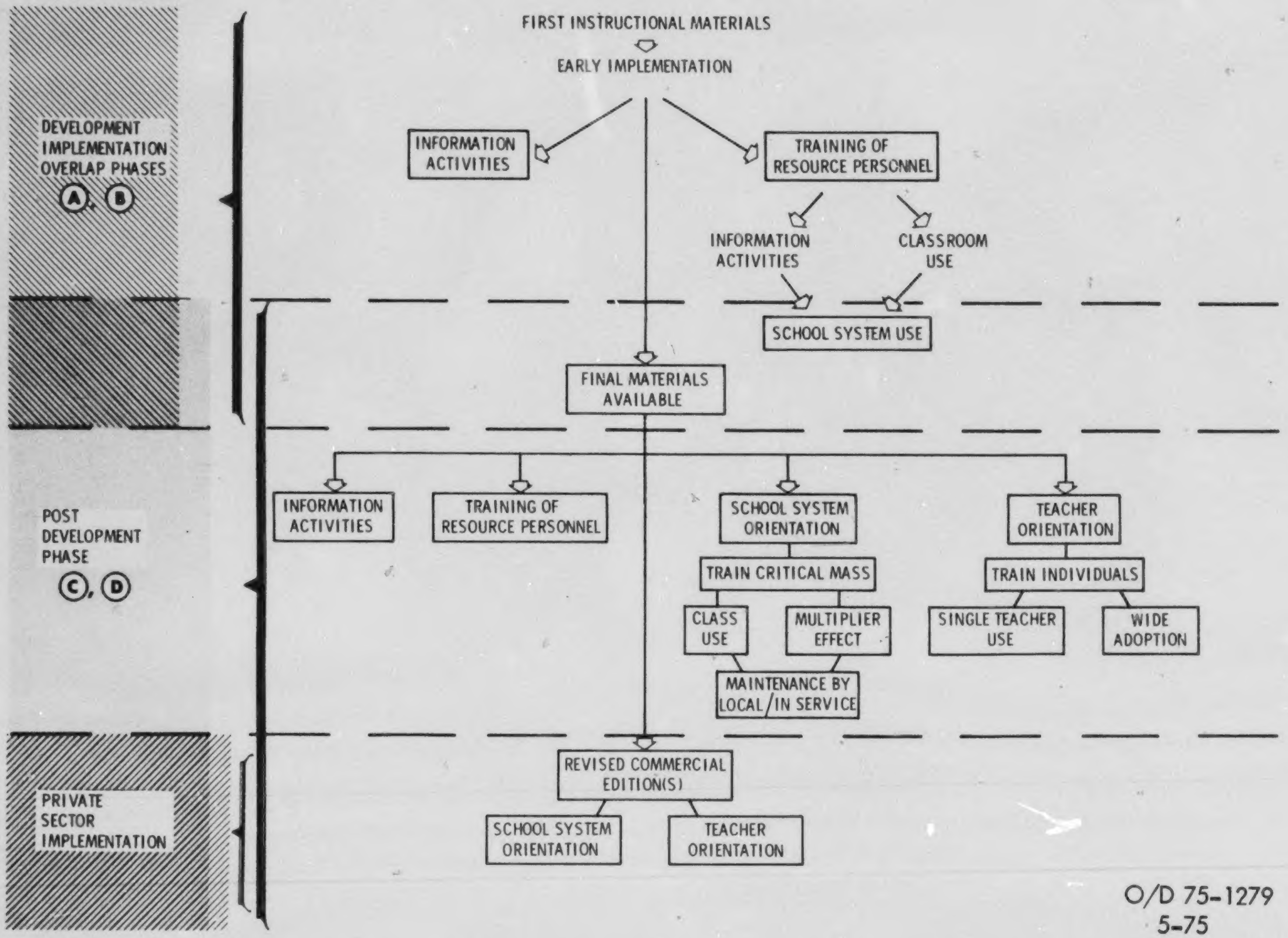
Director's meetings are held on a geographic basis. The agenda for these meetings is constructed to accommodate the needs of both school personnel and project directors and to provide an opportunity for the sharing of views which will contribute to the improvement of projects. Special information sessions dealing with NSF curricula have become an important feature of all these director's meetings. Project directors discuss project management, reporting procedures and general problems; school personnel consider means for greater involvement in the conduct of the projects; NSF staff presents data on grants and information on program goals, objectives and priorities. This latter serves as one of the ways in which NSF can influence the mix of proposals to be received in future years.

Each project director is required to submit an interim report at the conclusion of the summer phase and after the close of each major other than final, phase. Final reports are required following the conclusion of the project. Site visits also take place during monitoring, but only a small number of project sites are visited in any one year.

Schematically, figure 2 attempts to show at what time implementation activity starts. This is not an attempt to show a flow of activity. Figure 3 traces NSF involvement.

Implementation will include dissemination of information to school system decisionmakers about new and recently released curriculum projects, development of resource personnel among

MODEL FOR CURRICULUM IMPLEMENTATION



DEVELOPMENT IMPLEMENTATION OVERLAP PHASES
Ⓐ, Ⓑ

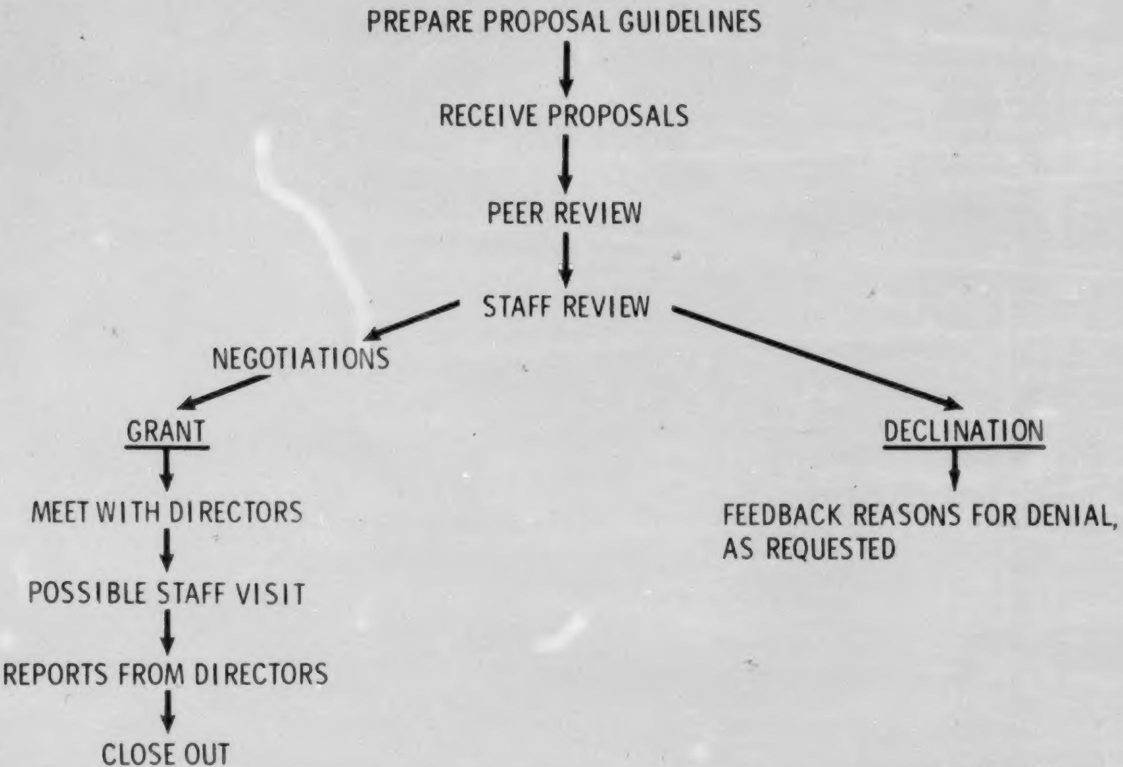
POST DEVELOPMENT PHASE
Ⓒ, Ⓓ

PRIVATE SECTOR IMPLEMENTATION

FIRST INSTRUCTIONAL MATERIALS
EARLY IMPLEMENTATION
INFORMATION ACTIVITIES
TRAINING OF RESOURCE PERSONNEL
INFORMATION ACTIVITIES
CLASSROOM USE
SCHOOL SYSTEM USE
FINAL MATERIALS AVAILABLE
INFORMATION ACTIVITIES
TRAINING OF RESOURCE PERSONNEL
SCHOOL SYSTEM ORIENTATION
TRAIN CRITICAL MASS
CLASS USE
MULTIPLIER EFFECT
MAINTENANCE BY LOCAL/IN SERVICE
TEACHER ORIENTATION
TRAIN INDIVIDUALS
SINGLE TEACHER USE
WIDE ADOPTION
REVISED COMMERCIAL EDITION(S)
SCHOOL SYSTEM ORIENTATION
TEACHER ORIENTATION

O/D 75-1279
5-75

NSF INVOLVEMENT IN CURRICULUM IMPLEMENTATION



PREPARE PROPOSAL GUIDELINES

RECEIVE PROPOSALS

PEER REVIEW

STAFF REVIEW

NEGOTIATIONS

GRANT

MEET WITH DIRECTORS

POSSIBLE STAFF VISIT

REPORTS FROM DIRECTORS

CLOSE OUT

DECLINATION

FEEDBACK REASONS FOR DENIAL, AS REQUESTED

O/D 75-1281
5-75

leaders with responsibility for initiating inservice education, orientation of influential teachers in new materials, and intensive implementation of new materials in a significant number of classrooms within a school system by cooperative projects with near-by colleges or universities.

The bulk of this work will be done under the auspices of local school systems, since there are far too many school classrooms for NSF to reach directly. NSF will encourage the development of competent resource personnel and assist in the introduction of new materials in a sufficient number of situations with enough visibility to gain favorable attention and simultaneously develop models or standards for implementation activities.

Summary

What has been described above is principally a process which leads to the development of new instructional material and its implementation. There are, of course, some obvious overlaps between the two processes, and in many instances it is difficult to sort out what is development and what is implementation. There has been a long history of concern with effective utilization of curriculum materials—not only those developed with Foundation support, but those developed without NSF support. Foundation procedures and policies in both areas have tended to evolve over the years as described in the historical presentation. Policy in these areas has been influenced by the necessity to avoid direct promotion of school system adoption of materials developed with Foundation support. Yet, in the discharge of its mission of improving science education, NSF has accepted the necessity for encouraging the effective use of quality classroom materials and practices. The Foundation has recognized that traditional U.S. policy places full responsibility for the selection of curricula on the appropriate local school authorities.

As the Foundation's investment in curriculum materials has grown, pressures have grown for the Foundation to accept some responsibility for assuring that the materials have an opportunity to gain acceptance by potential users. The Foundation does support the development of new instructional materials, innovative methods and, where necessary, equipment. While it oversees arrangements for the publication of curriculum materials it does not enter into the financial procedures between the developer and the publisher.

The Foundation does support certain types of implementation activities directed toward awareness of existing curriculum materials, both NSF and non-NSF, the training of individual teachers to effectively use these materials, and will assist school systems in installing these new materials and methods—but only to the point of providing expertise and training in their use.

The Foundation serves as a catalyst in stimulating improvement in many different school environments. Since it cannot support 17,000 school districts, it attempts to meet diverse needs by providing multiple access to improvements without being prescriptive or controlling. The purpose is to provide standards and examples which are highly visible.

Appendix 3

Publication Policy and Financial Arrangements

Procedures for Oversight and Evaluation

Publication Policy and Financial Arrangements

Before February 1969, NSF did not have any formal policy approved by the NSB on commercial distribution or income resulting from sale of materials developed under science education programs funded by NSF. Until then the policy was essentially set by an NSF memorandum to the senior staff from Dr. Waterman on copyrights. Based on this, internal procedures were established within the Education Directorate in the early 1960's. In essence, this memorandum stated that all relevant factors must be taken into consideration before an agreement could be reached on arrangements for copyright and distribution and that undue governmental interference was to be avoided in the course of normal competitive private enterprise; that where the publication would be made by an educational institution or university press, consideration should be given to profits being used to promote the general purposes of the grant or contract. Further, "in all cases, care should be taken to avoid financial advantage accruing to individuals through privileged use of materials or manuscripts having received Foundation support." Later, specific provisions were contained in individual grants or curriculum development projects. A sample clause in use in 1962 follows:

1. Arrangements for commercial production of properties developed under this grant should be such as to permit a number of appropriate and interested concerns to submit proposals for production and distribution.

   Selection of manufacturers, publishers, and distributors shall be made so as to assure wide distribution at a reasonable price.

   The Foundation is to be informed as to the plan upon which negotiations shall be based, including the companies to be approached, measures to assure that qualified concerns will have an opportunity to submit proposals for production and distribution and criteria to be used in selecting the successful bidder(s).

   All agreements entered into by the grantee providing for the use or distribution of books, films, patents, copyrights or other properties conceived or developed under this grant must be reviewed and approved by the Foundation prior to signature by the grantee.

2. Income derived from rents or royalties, or from the sale of books, films, patents or other property rights conceived or developed under this grant shall be placed in a separate account by the grantee and shall be utilized in ways approved or determined by the Foundation.

3. Recognizing that traditional American policy places responsibility for the selection of subject matter used in the schools in the hands of appropriate school authorities; public and private, the Foundation desires that the funds made available under this grant to be restricted in their use to the development of new instructional programs and materials and to the dissemination of information about them.

4. The grantee agrees that the Government may use, reproduce, or have reproduced and used, for Government purposes, all materials developed by the grantee in connection with this grant.

This type of clause evidenced the Foundation's intent to control the commercial publication of grant materials including the notification to the trade of the availability of materials, and approval of selection of the publisher and the publishing agreement.

An attempt was made to redefine the publication policy in November 1963. The draft statement is summarized in the list of the following principles.

1. An exclusive publication agreement for a limited period of time up to 7 years may be reached between a grantee and a publishing company after appropriate competitive bidding. Alternatively, non-commercial publication of sample materials for classroom use may be approved pending the appearance of similar commercial versions satisfactory to the project produced under normal individual author/publisher arrangements.

2. There should be no implication that the Federal Government or the Foundation has placed a seal of approval on these materials; they should make their way on their own merits.

3. Commercially published materials must be priced to be competitive in the textbook

market. This qualification is included so that materials developed through support with public monies will not have an unfair price advantage. In order that there not be an undue advantage to the publisher, normal royalties to the grantee are required.

4. Utilization of royalty income by the grantee is determined by the Foundation.
5. Publication arrangements include a termination clause so that the book may be withdrawn from the market after an appropriate interval if that becomes desirable.
6. All contracts must include a reservation on materials for Government use.
7. Control over content and all subsidiary rights (translation, etc.) remains with the grantee although the specific contractual arrangements are subject to NSF approval.

This policy contemplated various distribution arrangements, including exclusive publication of a hardback edition which could compete with other texts containing similar material for the same target population. This was adopted with respect to PSSC, BSCS, and CBA. A second technique used in the CHEM Study project was to hire a publisher as a printer with the grantee controlling the distribution. Another procedure was employed in the case of SMSG which published its materials in soft cover for sale on a nonprofit basis and encouraged large-scale "borrowing" from its materials on a non-exclusive basis by others who then prepared commercial hardback editions.

In March 1966, a different approach was taken to the period of exclusivity permitted the publisher by requiring the grantee and publisher to provide for the royalty-free use of the materials after a specified amount of time. A sample free-use statement follows:

> Permission is herby granted by the copyright owner to all persons to make any use of this work after ____________ ,* provided that publications incorporating materials covered by this copyright contain an acknowledgement of this copyright and a statement that the publication is not endorsed by the copyright holder. In the exercise of this permission, copies of the work or portions thereof may be made after ____________ ** provided that no public release of such copies is made until ____________ .*

By 1968 enough issues had been examined and tentative positions formulated with respect to these issues taken to frame a staff paper which was presented to the 117th Meeting of the National Science Board, March 21, & 22, 1968.

One particular issue which had not received much attention prior to this time was the problem of film distribution. Early policy had been generally consonant with the notion of exclusivity already developed for publications. The staff paper, however, presented the proposition that film distribution on a non-exclusive basis was feasible in view of the advent of a practical, inexpensive, 8 mm system utilizing cartridge load film loops developed by Technicolor.

As a next step, a preliminary discussion of the staff paper was held at the July, 1968 meeting of the Advisory Committee for Science Education. Because of limited time and the complexity of the problem, the Chairman of the Advisory Committee appointed an *ad hoc* committee to examine the film problem in greater depth. It was agreed at that meeting that the *ad hoc* conference should be held on September 25, 1968 at which time the participants, in addition to NSF staff, should include representatives of the publisher, film distributors, grantee institutions and members of the NSF Advisory Committee for Science Education and of the National Science Board. The one-day conference reviewed a revised staff paper on proposed publication policies. The results of the conference were reported to the Advisory Committee for Science Education on November 7-9, 1968 at which time the Committee endorsed the proposed policy positions presented.

The document entitled *Policies for the Distribution of Publications and Other Materials Developed Under the Science Education Programs of the National Science Foundation* was submitted as NSB-69-52 at the 123rd Meeting of the National Science Board, February 13-14, 1969. The Board approved the statement and requested that it be implemented "immediately but not retroactively". General distribution of the policies was made with an effective date of February 14, 1969. Since 1969 there has been relatively little change in the publication policy with the exception of new provisions dealing with the control and disposition of income which will be discussed later. Approved changes included:

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* The date to be inserted here is to be negotiated. It would usually correspond to the normal revision cycles of 4 to 5 years.

** This date would be in advance of the release by an interval sufficient to give publishers preparation and printing time.

1. The requirement of an acknowledgement and disclaimer clause which must be printed on the copyright page of the printed materials:

   "Development of these materials was supported in whole or in part by the National Science Foundation. Any opinions, findings, conclusions or recommendations expressed herein do not necessarily reflect the views of the National Science Foundation or the copyright holder."

2. Further, the free-license notice which is also to appear on the copyright page was changed to its present form which requires reprinting of the acknowledgement and disclaimer as well as the original copyright notice:

   "Except for the rights to materials reserved by others, the publisher and copyright owner will grant permission for use of this work, in whole or in part, in the English language in the United States, Canada, and Mexico without charge or other royalty after __________, provided that publications incorporating materials covered by these copyrights contain the original copyright notice and the statement: 'Some (All) of the materials in this work were developed with financial support of the National Science Foundation. Any opinions, findings, conclusions or recommendations expressed herein do not necessarily reflect the views of the National Science Foundation or the copyright holder.' For conditions of use, or permission to use material contained herein for foreign publications or publications in other than the English language, write to the publisher (copyright owner)."

3. "Domestic" distribution was expanded to include Mexico.

Income and Its Distribution

Income may arise from NSF science education grants by sale, rental, licensing or other disposal by grantees of texts, films and other materials developed or produced with Foundation support.

It has been the Foundation's long-standing policy that grantees should not profit from support received by the Foundation. Therefore, the Foundation has usually included a requirement in project awards that income be accounted for over a specified period, reported to the Foundation, and disposed of as directed by the Foundation. This is reflected in the sample clause (2) from the 1962 grant example on the first page of this section.

In most instances since the early 1960's commercial publishers have been required to pay royalties to inhibit them from underselling other available materials and gaining a competitive advantage as well as from realizing excessive profits—since they did not incur development costs. When the "free use" policy was instituted in 1966, the publisher's obligation to pay royalties was limited to the period of exclusivity. However, this was changed in the 1969 NSB Policy Statement which required the continuation of royalties unless the publisher could demonstrate that he had not recovered his investment. The negotiated royalty rates have varied from 3-20 percent and depend on a variety of factors including the price of competing materials, the publication and distribution cost of NSF-supported material and the contributions of the publisher.

In October 1964, the income policy was revised by a Memorandum from the General Counsel which was adopted by the Director in Office of the Director Staff Memorandum 61. This memorandum required NSF to remit to the Treasury escrow accounts resulting from royalty payments by publishers from sale of course materials. In addition, consistent with a recent GAO decision on revolving funds, the memorandum authorized the use of grant funds for the printing of trial editions and reuse of the income thus generated in a revolving fund for further printing and sale of such material. Any money remaining in the fund at the end of the sale period would be considered part of the grant so long as it did not exceed the initial amount provided for the printing.

Prior to this time, informal revolving funds had been used in several instances. For example, in 1960 SMSG was given permission to use $14,000 of income received from sales of texts and related documents for "general purposes of the School Mathematics Study Group" which included printing additional copies of materials for sale. In the same year, CBA received similar permission. A formal revolving fund was established in 1963 for the specific purpose of authorizing the University of California to use funds from the "income account" to reprint 50,000 copies each of the CHEM Study Text and Laboratory Manual.

However, in 1968 GAO questioned the authority of NSF to classify unused revolving fund money as available for general use, and in 1969 issued a decision that such money must be remitted to the Treasury in accordance with 31 USC 484. The Comptroller noted that since the proposed use of the remaining funds constituted an augmentation of NSF appropriations, specific statutory authority was required.

This GAO opinion precipitated a re-evaluation by NSF of its treatment of royalty income. After many drafts were written and discussions held with GAO, a revised policy finally emerged in January 1972 as Circular No. 106 (copy attached). Prior to its issuance, it was reviewed by GAO which indicated that it would raise no objection. It was then presented to the NSB by Director McElroy in November 1971. The Board, however, has never formally approved this policy.

In his memorandum to the Board, the Director noted that the proposed policy requested a change from the statement approved by the NSB on February 14, 1969, on treatment of income. For example, the 1969 policy required all income to be remitted to NSF except for amounts necessary to pay administrative costs related to the management of the income-producing property. In addition, provision was made for the release of income when the level became nominal. In contrast, the new statement provided for the use of income to offset costs of grant activities as well as administrative costs of the income-producing materials. Also, the new policy permitted the grantee with Foundation permission to keep all income and use it for science or science education purposes if the income was not expected to exceed $10,000. Any income over this amount was required to be remitted to NSF. This new policy was applied to income arising from either grants or contracts.

Income as defined in Circular 106 may also include interest on royalty accounts, a subject of continuing interest to GAO. Thus, if a grantee places royalties in an interest-bearing account, any accrued interest would be considered income and subject to the procedures and policies of Circular 106 and any income clause in the grant or contract. Circular 106 does not represent a change of policy in this area because interest could have been broadly interpreted to be covered by phrases in the income clauses in use prior to 1972 such as "income derived from rents or royalties" or "all income".

Income may also arise from the sale by the grantee of revision rights. Under present publication policy, a revision is treated the same as the original edition if the revision is developed during the period of exclusivity. Accordingly, royalties are owed on the same basis and must contain the same free-use statement. Revisions are not permitted to be published less than one year prior to termination of the exclusivity period. However, if the publisher brings out a revised edition at his own expense after the period of exclusivity has expired, he is free to use parts of the original work without payment.

NATIONAL SCIENCE FOUNDATION
Office of the Assistant Director for Administration
WASHINGTON, D.C. 20550

NSF CIRCULAR NO. 106

GRANTS AND CONTRACTS

January 25, 1972

Subject: **Income Under Foundation Grants and Contracts**

1. **Purpose.** This Circular establishes Foundation policy and delegates responsibilities governing the management and disposition of income generated under Foundation grants and contracts.

2. **Cancellation.** This Circular cancels O/D Staff Memorandum 61, Disposition of Foundation Receipts, dated October 22, 1964.

3. **Definition of Income.** As used throughout this Circular, income refers to that portion of gross revenues, including royalties, received by or accruing to a Foundation grantee or contractor through activities undertaken in the performance of its grant or cost-reimbursement type contract whether received during or after the grant or contract period. Income includes but is not limited to proceeds received by a Foundation grantee or contractor from the sale, licensing, lease, rental, or other arrangement for the use, release, dissemination, or other disposal of books, monographs, films, and other material and properties, except inventions, developed or produced with Foundation support. Income also includes any interest earned on all such revenues and proceeds, but interest earned on grant or contract funds is not included.

4. **Policy.** Prior to making a grant or contract award, the Foundation will consider the nature of the project, the purpose of Foundation support, the amount and source of expected income, and other relevant factors and determine what provisions the award should contain regarding the disposition of anticipated income. In the event that realized income is in excess of the estimated amount or unforeseen circumstances should arise, the grant or contract may be amended to provide for other appropriate disposition of such income.

a. *Grants.*

(1) All income will be accounted for and, normally, grants will provide that (a) income received by a grantee during the life of a grant will, to the extent practicable, be used by the grantee to offset costs otherwise allowable and chargeable to the grant and (b) income will be used to cover reasonable expenses associated with the administration of the income producing activity.

(2) Normally, where total income is estimated to be less than $10,000, the grant may provide that income not used as provided in the grant shall be retained by the grantee to be used for science or science education purposes, provided, however, that any remaining income in excess of $10,000, or such lesser amount as may be specified in the grant, shall be remitted to the Foundation.

(3) Where appropriate, grants may specify other uses for income such as (a) in certain deficit support type grants, income may be permitted to be used to cover reasonable expenses associated with the project during the grant period and thereafter which were not reimbursed from other sources, or (b) in certain grants where the purpose is to make an activity self-sustaining, income may be permitted to be used to continue the activity.

(4) Where total income is estimated to exceed $10,000, the grant will provide that all income not used as provided for in the grant will be remitted to the Foundation.

(5) All income required to be remitted to the Foundation will be kept in a separate account and will be reported on and remitted semiannually for ten years or such other period as may be specified in the grant, provided, however, that should such income fall below $2,500 per year, for any two successive calendar years, the requirement for further reporting and remittance may be waived.

b. *Contracts.* The disposition of all income in which the Foundation may have an interest shall be provided for in the contract and, to the extent appropriate, shall be consistent with grants policy.

(1) *Use of Income During Life of Contract.* Normally, income received by a contractor during the life of a cost-reimbursement type contract will be accounted for and to the extent practicable, unless otherwise provided by the contract, be used to offset costs chargeable to the contract.

(2) *Return Unused Income.* To the extent that income received or accrued during the life of the contract is not used as provided by (1) above,

such net income shall be remitted to the Foundation.

c. *Return of Interest.* Any interest earned on grant or contract funds shall be remitted to the Foundation and deposited with the Treasury.

d. *Return of Income.* Income remitted to the Foundation in any form by grantees and contractors will be deposited with the Treasury as provided by law.

e. *Income Reports to OMB and Congress.* All income and interest remitted to the Foundation by grantees and contractors or required to be reported on by grantees and contractors will be reported by the Foundation to the Office of Management and Budget and to Congress.

5. **Responsibilities.**

a. *Program Offices.* Foundation Program Offices are responsible for identifying, on the appropriate forms, proposed awards which are potentially income producing. Further, they are responsible for providing recommendations to the Grants and Contracts Office on the proposed treatment and use of income.

b. *Grants and Contracts Office.* The Grants and Contracts Office is responsible for:

(1) Verifying the income potential of proposed awards.

(2) Developing and including in income potential awards, appropriate clauses or requirements for the accounting, reporting, and disposition of income in accordance with the policies set forth in this Circular, and for coordinating with the Program Office, Office of the General Counsel, and other offices as appropriate.

(3) Receiving and reviewing all reports, proposals, and other communications from grantees and contractors regarding income, and, as appropriate, forwarding such documents to the Financial Management Office and Program Offices.

(4) Issuing all instructions, approvals, determinations, and other communications to grantees and contractors regarding income after coordinating with the Program Office and Office of the General Counsel as appropriate.

c. *Financial Management Office.* The Financial Management Office is responsible for receiving and accounting for income reported or remitted to the Foundation, for preparing periodic reports on income, and for disposing of income received by the Foundation in accordance with the policies set forth in this Circular.

d. *Budget Office.* The Budget Office is responsible for obtaining income information from the Financial Management Office and preparing the income reports to Congress, the Office of Management and Budget, and others as appropriate.

e. *Audit Office.* The Audit Office is responsible for the audit of Foundation grantee and contractor income, for reviewing their compliance with the income provisions of their grant or contract, and for otherwise examining and reporting on grantee, contractor, and Foundation practices and procedures regarding the management and disposition of income.

T E Jenkins

T. E. Jenkins
Acting Assistant Director
for Administration

Distribution F

Procedures for Oversight and Evaluation

Curriculum Content Oversight

NSF policy on oversight and evaluation for curriculum content has for the last ten years, been based on the program policy statements contained in the March 1965, *Status Report on the Course Content Improvement Activities of NSF.* Article 2 of the report sets a requirement for "first-quality scientific leadership" in NSF supported projects; Article 6 states that "study groups are to be given the fullest freedom to develop their materials according to their best professional judgment" and that "their professional judgment should not be influenced unduly by any vested interest group nor by any member of the National Science Foundation." Further, "there must be no implication of governmental responsibility for, nor endorsement of, the content or organization of the materials." Article 7 requires that "both the Foundation and project staffs disclose to responsible individuals and organizations, including commercial organizations, information on the work of a project."

During analysis of these procedures, the subject was approached from the viewpoint of "what happened"; a subjective judgment was not made as to "what should have happened." The milestones for determining "what happened" are similar in the evolution of any curriculum improvement project. Oversight and evaluation takes many forms; internally by NSF management and staff review, and externally by mechanisms such as peer review of proposals, reviews by members of the teaching and publishing communities, and evaluation by students and parents.

During the curriculum development phases, three distinct stages are evident—(1) the pre-award period during which a project is being planned and organized and a proposal prepared, (2) the award period during which most of the substantive work of the project is carried out, and (3) the "overlap" period during which curriculum materials are finalized, testing nears completion, publication arrangements are made, and teacher training begins.

The procedures for oversight and evaluation for content appear to be unique to each of the cases studied at every stage of development. In the case of *CHEM Study*, the proposed concept and design were subjects of active consideration during visits preceding the formal review of the proposal. NSF staff attended meetings of the steering, planning, and organizing committees and was kept fully informed on the direction the project would take. Proposal revisions were made within a month and deficiencies cited by reviewers were corrected. In contrast, since the NSF staff judged that coordination of the *Comparing Political Experiences* (CPE) project by the American Political Science Association filled the need for the pre-award oversight function, no site vists were included in initial considerations. In the case of *Science Curriculum Improvement Study* (SCIS), *Man: A Course of Study* (MACOS), and *Individualized Science Instructional System* (ISIS), the reputation of the principal scholars and peer review performed by experts in the various fields formed the principal basis for the pre-award oversight function without extensive NSF staff involvement. NSF staff members were however, involved in ISIS needs asssment conferences.

As each project approached the award stage, the oversight and evaluation function evolved. The original steering committee for *CHEM Study* performed the oversight function and provided overall direction to the project. NSF staff participated in steering committee meetings. A pattern of advance planning with NSF feedback and subsequent action was firmly established in the project. A *CHEM Study* newsletter was developed to inform the community of the group's activities and was mailed to school supervisors and teachers around the country. In addition, formal descriptions were published in a variety of educational journals to reach a wide audience. Copies of all materials produced were received and reviewed by NSF staff.

During the initial stages of the development of *Man: A Course of Study*, an oversight committee was formed, variously referred to as a planning or executive committee. It consisted of scholars from prominent universities and grantee top management. There was little NSF-grantee interaction during curriculum development. Primary reliance was placed on peer review of proposals requesting additional support, and on progress reports included in these proposals.

The basic philosophy for oversight of Com-

paring Political Experiences (CPE) was to place major reliance on a highly qualified Project Director and to provide only minimal monitoring. As is the case in other grants, major reviews occurred annually when requests for additional funds were received.

No defined monitoring or reporting requirements were initially planned for SCIS; reliance was placed on annual reviews of renewal proposals. Site visits and major reviews were conducted to iron out problems as they occurred. The oversight system was informal and mainly in response to requests of the Project Director, until later when an oversight committee evolved within the project team.

The oversight function of ISIS rests with the Project Director and an advisory committee which includes scholars with a variety of backgrounds and interests (see ISIS case study).

Content evaluation procedures also took a variety of forms during the development stage. A content evaluation system was built into the *CHEM Study* project from the outset. The first draft of the text was written and put to use by participating teachers who fed back their own and student reactions. Modification and revision was a constant process over a two year period at the end of which the final text was virtually complete. Prime responsibility for selecting and evaluating content and accuracy of the material resided with the Steering Committee.

For MACOS, the grantee supported an evaluation study which resulted in the publication, *Curiosity/Competence/Community: Evaluation of Man: A Course of Study*. (Hanley, J.P., Whitla, D.K., Moo, E.W., and Walter, A.S., Education Development Corporation, Cambridge, Mass., 1970) The evaluation of the early pilot verions of the course revealed problems in several lessons and materials on which the developers based revisions. In addition, a grantee evaluation of the 10th grade materials led to their decision to discontinue development of these materials as originally envisioned as part of this Social Studies Curriculum Project. An EDC proposal of 3/29/68 requested funds for continuation of the 5th grade curricula and a new 10th grade curricula. NSF elected to support only the 5th grade segment of this proposal. NSF is currently supporting an evaluation of MACOS by Russell Cort of Antioch College.

In *Comparing Political Experiences* a content evaluation function was contemplated in the original proposal and was acknowledged in the grant instrument as being the responsibility of the Project Director. The grant instrument cautioned that results of the activity were the responsibility of the grantee and not to be represented as being by or for the NSF or the U.S. Government. As of April 1975, a formative evaluation was being conducted at pilot schools by staff of Indiana University (subcontractor) and the American Political Science Association.

The *ISIS* project evaluation plan calls for individual approaches to the formative evaluation of each module of the curriculm. A modified Delphi technique is to be applied to provide a reasonable range of opinion held by acknowledged experts in the field. Evaluation specialists and module authors will be provided baseline data from tryout school records. Teacher and student opinions will be collected by questionnaire and/or direct interview. The evaluation features of this project are built into the grant operation to be carried out by the Florida State University project staff.

The evaluation procedure for SCIS, although not included in the original proposal, was built into grant amendments and included pilot studies in Michigan and New York schools as well as a formal independent evaluation which resulted in a report upon which revisions were based.

In viewing procedures during the implementation phase, it becomes evident that the requirements for oversight and evaluation for content is reflected in the publication arrangements and in the mechanisms used to disseminate information about the curriculum projects. There appears to be a degree of overlap between the development and implementation phases because the project oversight committees and teams continue to interact with the publishers and marketers of the course materials. New oversight forces enter the picture, however, as school systems are made aware of the materials and the system decisionmakers, resources personnel, and classroom teachers are given the opportunity to review the materials, work with them and evaluate them. In this way, *CHEM Study* had great success in gaining wide public acceptance of materials content and new teaching concepts. MACOS, on the other hand, has encountered controversial views on content and the innovative features of its multi-media materials and teacher training programs. For the most part, the NSF position on implementation has been that traditional American policy places responsibility for selection of subject matter used in the schools in the hands of appropriate school authorities, public and private.

The *CHEM Study* grantee published reports on the project in national journals and mailed a newsletter to school districts around the country. One of the first *CHEM Study* films enjoyed great success and was shown to a wide audience on national TV, many requests for information were received by the project staff. Gradually, teacher institutes adopted *CHEM Study* materials and as teachers became acquainted with the new materials, they were adopted for use in classrooms around the country.

MACOS has received a great deal of publicity and remains controversial. Numerous scholarly articles have been published in professional journals, the innovative and controversial features of the course have been aired in newspapers and magazines and Congress and the public at large have debated the pros and cons of the course material in print and on television.

MACOS implementation began in 1969, initially by the developer with NSF support, and since 1970 has continued through course developer-commerical publisher arrangement. Major features are the requirements for teacher training, a developer-publisher program of R&D on course materials which provides results of their efforts to users on a continuing basis, and other awareness mechanisms where content is analyzed and evaluated.

SCIS evaluation procedures during implementation included a field test of evaluation supplements for the three upper levels of the program during the 1973-1974 school year in which about two hundred teachers participated. Many articles have been published about this course in educational journals, films are available to explain it, and its content has been a topic in several workshops, institutes and other teacher and resource personnel training programs.

The materials from ISIS have not yet been fully implemented, however several journal articles have been published and a regular developer-issued newsletter is sent to the participating trial centers and school districts.

Comparing Political Experiences (CPE) is still in the development stage and its content continues to be subjected to scrutiny in local school systems and by individual schools. Complete data are not readily available on the impact of implementation activities.

OVERSIGHT OF IMPLEMENTATION

The Federal Government has an important role in assisting State and local educational units to create equal education opportunities and in establishing standards and models for educational processes. States and local school districts come to the Foundation for assistance in this process and the Foundation supports projects which directly or indirectly involve State education agencies. It is felt that in the real world it is simply not sufficient to develop good materials—they will not be used unless they are given a healthy push. Some publishers try to assist schools with training workshops but admit that their efforts are often superficial and inadequate. Implementation is expensive, and the book publishing industry is relatively small and facing serious economic problems. New programs other than those supported by NSF frequently gather dust because teachers lack the knowledge base and training to use them. Because of this, the Foundation welcomes implementation proposals for other than NSF sponsored curricula; without adequate teacher training the investment for their development would be lost.

All the major curriculum projects have more or less systematic information programs associated with them, including publication of newsletters, preparation of articles for professional scientific and educational journals, replying to requests for information in person and by letter, and oral presentation upon invitation before scientific, educational and lay audiences. Progress reports appear periodically, copies of preliminary versions of textbooks and other materials are made available to all interested persons. Projects of lesser scope use similar channels, but on a reduced scale, with principal reliance on publication and dissemination of final reports in journals and other publications. In the early years of Foundation activities in curriculum improvement, it was felt that in addition to the information activities, it would be necessary in some manner to provide adequate teacher preparation for the teaching of the new curriculum in the various schools in the country.

The first secondary school institutes used were NSF sponsored as a vehicle for training teachers in the utilization of newly developed curricular materials beginning in 1958. Between FY 1958 and FY 1961, teacher training in curriculum materials for UISCM, PSSC, SMSG, CBA, CHEMS, and BSCS was included in the summer institutes program. In attending these programs, no teacher was required to install one of these revised courses in his school.

With the termination of the summer and in-service institutes for elementary school teachers in 1966, the Cooperative College-School Science Program (CCSS) became the sole vechicle for assisting elementary school personnel to receive training in new curriculum materials. The earliest CCSS programs were participant-centered, and their effects on school systems were transmitted through students and teachers—the students bringing a sense of need and urgency back to their school and the teachers bringing back some answers to that need. Several institutions devised CCSS programs with the immediate purpose of helping schools introduce new course material.

A series of conferences were supported beginning in 1967 to disseminate information about new curricular efforts.

An NSF-supported conference was held at the University of Maryland in January 1967. The conference focused on implementation problems associated with elementary curricula but many of the conclusions were easily translated to the secondary school segment. In FY 1970 a larger share of the Course Content Improvement Program allocation went into the implementation activity and even though there was no restriction with regard to consideration of non-NSF supported curricula improvement, most of the projects supported through this program involved NSF-supported curriculum endeavors.

Beginning in FY 1974, the Foundation in its newly established Instructional Improvement Implementation Program, provided a coordinated focus for all implementation activities of curriculum revisions.

As discussed, implementation activities have been carried out through a number of different programs. In the early years, proposals submitted to the Foundation in the various programs such as Summer Institute Program, In-Service Institute Program, Academic Year Institute, CCSS, and so forth, received a peer review. A typical review in the Educational Directorate involved convening a large number of panelists at one time, assigning them to panels of three individuals, each with a panel leader and asking each panel to review a specific number of proposals. Each panel's proposals were then reviewed by at least one other panel of reviewers. The ratings of the panels were reviewed by NSF staff. Awards were based on the Program Director's own knowledge plus his judgment of the impact of the reviews.

The NSF role has been limited to providing support of curriculum improvement. The Foundation staff does not play a strong role in the oversight of the effectiveness of the implementation activities even though there are interim and final reports available and site vists are sometimes made. The *NSF Guide for Preparation of Proposals and Operation of Projects for Instructional Improvement Implementation* contains the following:

> "Project Evaluation
>
> The adequacy of the evaluation plan will be considred in the review of the proposals. The Foundation expects that effective proposals will include plans for evaluation to determine whether or not the specific objectives of the project have been achieved. The plan would also normally include strategies for gathering information to assist project directors in improving their projects in the future."

The *Pre-College Education in Science Program Review* of January 21, 1975, contained statements to the effect that, "Studies focused on implementation issues such as the persistence of innovations, analysis of the cost-effectiveness of different implementation approaches, analysis of the factors affecting the extent and quality of implementation, etc., should be pursued. Baseline data on current usage of materials, the impact of our implementation strategy, and assessment of the different implementation models are needed. These are only a few of the many issues which must be addressed to obtain information for practitioners to use in improving implementation mechanisms and approaches and for the improvement of our own activities."

Appendix 4
Summary Case Studies

Five curriculum development projects were chosen for detailed study by the science curriculum review team. Synopses of these Case Studies were presented in Volume I of this report. This appendix presents the complete summary reports prepared by members of the review team. Problems suggested after examination of the assembled materials on each case study are summarized and were used as background for the recommendations of the Advisory Committee for Science Education and those of the chairman of the review team (Volume I, Section III).

Additionally, most of the case studies include grant information, lists of courses developed and detailed data on development and implementation processes.

The case studies are presented in the following order:

1. CHEM Study
2. Science Curriculum Improvement Study (SCIS)
3. Comparing Political Experiences (CPE)
4. Man: A Course of Study (MACOS)
5. Individualized Science Instructional System (ISIS)

As noted in Volume I, these curriculum development projects were chosen for detailed examination because they represent different disciplines, are at differing stages in the total process and illustrate ways that the process from proposal to implementation has varied over the years.

CHEM STUDY

Chemical Educational Materials Study (CHEM Study); *University of California, Berkeley;* $2,766,160; 1960-1972; Grades 10-12

The subject grant was initiated in April 1960 and was continued over a 12 year period, terminating in December, 1972. Its objective was "Organization of a chemical educational materials study to prepare, through research and study, textual and experimental material to aid in development of a modern chemistry teaching program for U.S. high schools." Including earlier awards to develop plans for the project, NSF invested $2,766,160. The royalties accrued from the materials produced under the project and remitted to the United States Treasury came to $3,563,794. An additional $463,654 was reawarded by NSF.

More than $2,500,000 had been awarded by the end of 1962, but the grant was left open to provide for reprints of the material and the return of royalties to NSF. Occasional modest amendments were made during the ensuing years to cover administrative costs. The grant was terminated following a projected accounting which indicated, essentially, that the administrative costs associated with the return of royalties to NSF would exceed the anticipated royalty income.

At this time the decision was made to release the University of California, Berkeley, from further obligation to remit royalties to NSF.

The published material developed in the CHEM Study program included the textbook, laboratory manual, teacher's guide; a series of achievement examinations; supplementary programs introducing exponential notation and slide rule; film transcripts and a teacher's guide to the films. In addition, 29 films were produced. These were designed to introduce data that could not be acquired through student experiments and to provide clarifying models.[1]

The written materials could be used together or as individual supplementary components. Films could be obtained on a subscription, purchase, or lease with option to buy basis and arrangements were made for previewing them. Additionally, reading lists, wall charts, and laboratory equipment items were developed for flexible use depending on situations.

The history of the development of the project can be understood more easily if placed in the context of the early period of the Foundation's history. From its beginning, NSF established the policy of using advisory panels composed of outstanding individuals from the private sector to assist in determining how the Foundation could best fulfill its congressional mandate. Minutes from the early meetings between NSF staff and the Advisory Committee for Education substantiate that as early as 1954 NSF considered improvement of science curricula to be one of its objectives. There was concern at that time that recent developments in the sciences were not being incorporated into traditional curricula and that the sciences were not adequately presented in high school curricula. During the mid-fifties attempts to remedy these shortcomings at the high school level largely took the form of small conferences between research scientists and high school teachers from selected disciplines along with a modest effort to develop supplementary aids for specialized areas.

Following discussions with the advisory group, NSF determined to develop a more comprehensive program for curriculum development. Textbooks were seen by NSF and the experts as badly in need of revision, thus at this time the policy was initiated of soliciting top-flight scientists to undertake revisions in cooperation with high school teachers. The initial statement of general principles in support of course content improvement was developed and endorsed by the Advisory Committee at its November, 1975, meeting.

The growing concern over the perceived deficiencies created a climate of thought in the late fifties among research specialists which led them to become increasingly willing to devote personal effort to their correction. The coincidence of interests between NSF staff and the scientific community furnished the impetus for substantial efforts in curricular development.

The first major curriculum revisions undertaken by NSF were in physics, biology and mathematics and it is against this background that the chemical scientists were actively discussing new content for chemistry courses. During 1957 through 1959 the Education Division had a succession of chemists on its staff who were active in this effort before, during, and after their tenure at NSF. During the same period, the American Chemical Society (ACS) and private foundations were independently stimulating similar efforts.

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[1] For titles, see *The CHEM Study Story*, R. J. Merrill and D. W. Ridgway, W. H. Freeman and Co., San Francisco, California, 1969.

The conference that resulted in NSF's first award for revision of a chemistry text was held in June 1957 under the sponsorship of ACS and the Crown-Zellerbach Foundation. Apparently some participants believed that the "Chemical Bond Approach," conceived at the conference, would not satisfactorily meet needs and continued efforts, through the ACS Division of Science Education, for a second undertaking.

An ACS *ad hoc* Committee on Education (chaired by a former NSF rotator[2], and ACS member) arranged a two-day conference in Washington with NSF representatives to discuss plans. An ambitious scheme for revising texts, lab manuals, and supplementary aids was outlined and received the unanimous endorsement of the ACS group along with strong encouragement from NSF.

It was agreed, in the interest of soliciting opinions other than those represented at the conference, that an Interim Planning Committee should be formed. Dr. A. B. Garrett, Ohio State University, was named chairman and support for the activity of the group was obtained from NSF in the spring of 1959. By fall, ideas on content and approach had taken shape and a decision was made that the extensive cooperation of the scientific community to bring the effort to fruition was likely to require a leader of Nobel-laureate stature. Consequently, ACS and NSF approached Dr. Glenn T. Seaborg, University of California, Berkeley, and asked him to assume leadership for the proposed revisions. Dr. Seaborg agreed, pending the acceptance of Dr. J. A. Campbell, Harvey Mudd College, as Director of the project. A steering committee of experts was established and within a very short time this group (with NSF support) had developed a detailed plan for content; had compiled lists of contributors, writing groups, and trial teachers; had set target dates and had completed an outline for the initial testing of materials in high school classes.

A formal proposal of this plan was submitted to NSF for review. It received enthusiastic endorsement both from NSF staff and most external reviewers. Suggestions for revision were also received. NSF believed the revisions should be made and forwarded a commentary to Dr. Seaborg. The changes were incorporated and following review by the Chairman and Vice-Chairman of the National Science Board an award to initiate the curriculum development was made. Subsequent amendments in excess of $250,000 were reviewed by the full Board prior to award.

In view of the interrelationships of NSF staff, ACS membersip and the participants in the CHEM Study Project, suggestions of elitism, or the operation of a 'buddy system,' etc. might have been raised concerning the award of the grant, however:

- NSF was committed to selecting the best professional help it could find in initiating the effort, and it did so.
- The major professional society in the field was equally concerned with and actively participated in improving curricula.
- The NSF reviewers and advisors, and major participants on the grant were acknowledged experts and individuals who exemplified the highest professional standards and integrity.
- The participation of these individuals was an act of service to scientific education. Salaried personnel were compensated at a no-loss, no-gain basis with respect to former jobs. None of the participants received royalty income; this was remitted to the U.S. Treasury (except for $463,654 used by NSF) and in amounts which exceeded the original amounts awarded. Furthermore, the texts that were published do not carry the authors' names.

An independent assessment of the success of the project revealed the following:

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[2] The Foundation has had a long standing policy of appointing some of its professional staff on a temporary basis (1-2 years). The aim is to augment the capabilities of permanent staff by individuals who are engaged in current research. The appointees generally come from academic situations, but occasionally also from industry and governmental organizations. The principles are somewhat similar to those in the Intergovernmental Personnel Act of 1970.

1. By 1965 the material had been adopted in many parts of Canada, India, New Zealand and Australia.
2. By 1965 individual films of the series had received 23 awards in major national and international competitions.
3. By 1968 the material had been translated for use in 13 foreign countries.
4. Between 1963 and 1968, 10 new texts for high school chemistry were published. Seven of these reflected the combined influence of the CHEM Study project as well as a second NSF-supported project, "The Chemical Bond Approach."
5. The materials were widely and quickly adopted in U.S. high schools and their use persists to the present. Some states have adopted parts as "required"; others as "optional." The minimal persistent use is estimated to be on the order of 25 percent of all high school students. The CHEM Study materials, including revised versions and derivations, runs well over 60 percent usage.

Review and Oversight History

Mechanisms developed for review and oversight of this project reflect traditional practices of the Foundation. NSF professional staff has the responsibility to stay informed on scientific progress in a field at both the national and international level. By definition this requires acquaintance and communication with the scientists carrying out the work. Generally, a new NSF activity is initiated by the staff following thorough study and informal discussions with scientists. In response to complexity of the area, experts are brought together in an *ad hoc* workshop or conference. Following its development, a concept is most often presented to a formal advisory committee for further deliberation.

After a decision is made to develop an area, the Foundation uses a variety of mechanisms to announce its interest in receiving and reviewing proposals; those received are then subjected to review by staff, external experts, and also often by panels convened to evaluate relative merits of several proposals. Proposals recommended for funding in new program areas are then presented to the National Science Board for review and approval. Currently, there is a requirement that any award in excess of $500,000 per year or which carries a total obligation in excess of $2,000,000, must be presented to the Board for review.

In the case of the CHEM Study proposal, there was staff review as well as review by experts outside the Foundation prior to that of the NSB. Thus there was collective consideration by some 16-20 experts in addition to NSB review on the merit of the proposed curriculum revision; the extent to which revision was necessary and the probable value for high school level education. Competence of the primary participants was considered and it was agreed that they would complete the project responsibly and with scientific accuracy.

The role of the Steering Committee was one of the key factors that led to favorable reaction to the proposal and this committee was to persist as the advisory and policy group for direction of the project. It was composed of outstanding chemists, academic and industrial, from around the country and included educators experienced at the high school level as well as representatives of the textbook and film industries who provided guidance in business matters.

This committee mechanism considerably lightened the burden on NSF staff for primary content review; the prime responsibility for selecting and evaluating content and accuracy of the material resided with the Steering Committee. However, NSF closely monitored developments and participated in meetings of the Steering Committee throughout the development, revision and evaluation stages and thus had ample opportunity to represent its viewpoint.

Contractual Arrangements

In December 1960, the CHEM study staff solicited, through the American Textbook Publishers' Institute, rough estimates and outlines of capabilities from all parties interested in servicing, printing, and distributing the definitive edition of the textbook, laboratory manual, and teachers' guide. About a dozen replies were received and reviewed by the Steering Committee. Three companies were requested to submit formal bids based upon detailed specifications approved by the University of California. The Steering Committee and CHEM Study staff then analyzed the bids and recommended that W. H. Freeman and Company be awarded the contract. Copies of the proposed contract between the University and W. H. Freeman were submitted to NSF for review. The Assistant Director for Education advised the University's Graduate Business Office that the contract was satisfactory to NSF in all respects—substance, control of the content and utilization of the publications by the University and CHEM Study staff, and administrative, financial and legal provisions.

Criteria for the selection of a publisher and distributor were reasonable. They included consideration of the quality and style of the sample text submitted, experience of the publisher with textbooks, proposed working arrangements, competence and policies of the publisher, distribution function, and promotional facilities.

W. H. Freeman also published and distributed a book, *The CHEM Study Story.*, whose cost was charged to the grant. The contract was not awarded on the basis of competitive bids. CHEM Study staff had reviewed this matter with American Textbook Publishers Institute and was advised that the arrangement would not raise objections from other publishers because of its limited distribution.

Royalty income received from the sale of materials totaled $4,027,448, of which $3,563,794 was deposited by NSF with the U.S. Treasury as miscellaneous receipts. The remainder, $463,654, was returned to the NSF Director's reserve account; the program office, consistent with existing NSF policy, had authorized the use of an equal amount of grant funds for printing materials with the understanding that the funds would be replaced from sales income. Such treatment of royalty income was a matter of inquiry by the General Accounting Office and subsequently resolved by the NSF Office of the General Counsel and GAO. A new income policy was promulgated under NSF Circular No. 106,[3] dated January 25, 1972.

Almost from the beginning of the project, CHEM Study staff devoted much thought and discussion to the problem of how to maximize the influence of the study without perpetuating the activities of the project. Various alternatives for the disposition of the publishing rights and revision rights were considered, including public domain, outright sale of all rights to one publisher, continuation of present policies without revision of the books, and authorization of two or more revisions. In July 1965, publishers were informed of the Study's intent to invite proposals for revisions of the CHEM Study Textbook, Lab Manual, and Teachers' Guide.

The major conditions in revision rights were to be granted to no less than two nor more than three publishers; selection would be based principally on the qualifications of the writing teams proposed, i.e., scientific competence, writing ability and teaching experience of the chemists and teachers as evidenced by their published works and reputations as teachers. Selection of proposals would not be based on financial considerations, but a standard flat fee was to be paid by the publishers selected for the rights. Three publishers were selected for revisions. Each paid CHEM Study $35,000 for the right to publish and CHEM Study did not collect royalties on the published revisions.

A substantial number of companies were contacted to determine their interest in producing CHEM Study films. Producers were chosen on the basis of competence and willingness to leave substantive control completely in the hands of the Study. These contracts, for the production of films only, cost from $11,500 to $21,650 each. There were no royalties involved, and the rights to the films were retained by the University. To obtain a distributor for the films produced and/or purchased, CHEM Study contacted 36 film distributors, of whom 13 indicated interest; three were requested to submit formal bids. NSF approved all negotiations.

A draft copy of the film distribution contract was submitted to NSF for review and comment. NSF advised the University of California that it had no objection to contracting with Modern Talking Picture Services, Inc. and the contract was executed February 19, 1963. Copyrights to the films are held by the University of California but the U.S. Government may use or reproduce the material for governmental use without charge.

Modern Learning Aids, the division of Modern Talking Picture Services which distributed the films, paid the University a 20 percent royalty on net receipts from the sale or "lease-to-buy plan," and it paid a royalty of 5 percent on net receipts for films distributed under the "subscription plan." The contract was amended May 10, 1968, permitting the distributor to distribute, in cartridge form, film loops excerpted by the Advisory Council on College Chemistry from the CHEM Study films. The royalty arrangement for the distribution of the film loops was the same.

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[3] A copy of this circular is found in Appendix 3.

Royalty income was remitted to NSF and deposited with the U.S. Treasury.

It was recognized that perhaps the most important factor in selection of a film distributor would be the integrity and enthusiasm of the organization doing the job. Nevertheless, it was also necessary for the distributor to have internegatives made at his own expense, purchase and stock preview prints, handle service rental orders and sales of prints, and to print and distribute teachers' guides for each film. Further, he must be prepared to distribute in eight millimeter, if feasible, and if requested by CHEM Study, would publicize the films on an aggressive basis and actively promote sales, would pay a royalty on prints sold and on rentals, and would be responsible for financial arrangements.

Selection was based on an analysis of prices to users (sales and rentals), method of publicity, methods for selling and renting, services to users, other chemistry subjects being promoted, and royalties. Royalties were considered to be of least importance.

The latest information in the NSF files (March 30, 1971) indicates that Modern Talking Pictures submitted a pricing policy to CHEM Study's Executive Director for the 12 months beginning July 1, 1971. According to an NSF program official, no additional information has been received concerning the distribution of the CHEM Study films.

Information contained in the Foundation's files indicates that the CHEM Study project was managed in accordance with NSF and NSB policies on distribution, royalties, and copyrights, and that good business practices were followed.

Two examples found in the files reflecting NSF responsiveness to private enterprise can be cited:

> "The Foundation met with representatives of the publishing industry to include their views in terms of modifying the policy of assigning exclusive publishing rights. The meeting also considered the problem of availability of 'non-commercial' materials during the testing period."
>
> "The Foundation in 1965 revised its policy of distributing free books to institutes in response to a request from the American Textbook Publishers Institute."

Monitoring History

NSF staff followed development of the project closely. Fiscal reports and annual reports of progress were required in the terms of the award. At a managerial level, the NSF staff was essentially in continuous contact with the progress of the project. Informal reports were frequent and advice on and confirmation of proposed directions were given prior to undertaking the activity. Questions involving selection of publishers and distributors, contractors, royalty income, etc. were forwarded to NSF legal counsel for verification of compliance with NSF and Federal policy. The pattern of advance planning with NSF feedback and subsequent action was firmly established in the CHEM Study project. The project directors, in turn, made conscientious efforts to keep NSF fully and currently appraised of progress and solicited advice on anticipated directions and problems.

The NSF staff made frequent site visits to the central project office at Berkeley and to regional centers after they were established. They attended planning and writing sessions as well as meetings of the Steering Committee. A CHEM Study newsletter was developed to inform the community of the group's activities and was mailed to school supervisors and teachers around the country. In addition, formal descriptions were published in a variety of educational journals to reach an extended audience.

Copies of final materials were received and reviewed by NSF staff. Staff involvement in the project was complete, continuous and thorough. The staff was kept informed on program areas that proved troublesome or required revision. In some instances it became clear that previously unplanned supplementary material should be developed. Although some of the material had not been identified in the original request, modifications were incorporated with NSF concurrence (e.g., *A Programmed Sequence on Exponential Notation; A Programmed Sequence on* *the Slide Rule.)* In 1966, accounts were audited by NSF and only minor changes were required in accounting procedures concerning indirect costs; no improprieties in the use of funds were found.

Evaluation of content was built into the project from the outset. The first draft of the text was written and put to use within three months. Teachers who participated in the writing also used the material in their classrooms. Additional teachers within a radius of about 50 miles of Berkeley used the text the first year. Reactions of teachers and students were fed back to the project director after use of a section so that modification and revision of the text was a continuous process. Periodic meetings between project staff and participating teachers were held to exchange ideas.

By the second summer the text was introduced in several NSF summer institutes, and subsequently in others sponsored by private, local and State groups expanding the roster of participating teachers. By the second academic year the text was virtually complete; the teacher's guide was developed almost entirely as a result of suggestions from teachers. In subsequent years greatest effort was devoted to development of supplementary material, again using the mechanism of testing, evaluation, feedback and revision.

A retrospective reviewer of this project is impressed by the efficient management and intensive dedication of the participants. During the development phase this meant coordinating the efforts of a large staff, 23 writers, 22 film collaborators, 15 center directors and more than 130 trial teachers from 35 states and Puerto Rico. Suggestions for revision, problem areas, student and teacher evaluations were assimilated and acted upon under the advisement of the steering committee and NSF. Deadlines were met, and copies of material were available for testing by the end of the first summer's work. The final text was essentially ready after the second summer, with subsequent efforts concentrating on lab experiments, specialized aids and teacher training.

By 1963, NSF was giving considerably more attention to problems of evaluation associated with course content development. Questions related to the soundness of the material, the ease of learning, appropriateness of sequence, etc. led to explicit encouragement by the Foundation of grantees to incorporate evaluation procedures at an early stage in the project's development.

Implementation History

It was determined early that materials produced should be competitive with current texts and that the packaging should be flexible in order to allow selective utilization and easy adaptation of both equipment and supplementary materials. It should be recalled that curriculum development and such ambitious revisions of material were highly innovative and experimental undertakings in the late fifties and early sixties. There were few similar experiences to draw from in terms of tested implementation practices. Policy discussions among NSF staff, Advisory Committees and the participants on the project recognized that "product acceptance" and utilization were the ultimate goal for this effort. Yet, at the same time, NSF repeatedly reiterated its position that its funds could not be used for promotion and distribution of the materials and that selection of materials for use in schools resided with State and local authorities. Funds could be used for the dissemination of information about the project, and indeed the grantee was obligated to publish reports on the project in national journals.

One of the first films enjoyed great success and was shown to a wide audience by way of national T.V. The participating staff responded to requests for information by letter or by personal appearance.

Early on, inadequate teacher preparation in the sciences was recognized to be as much a problem as poor curricula. Indeed, the Foundation's attempts to correct this problem had led to the development of a fairly extensive summer institute program well before the initiation of major curriculum revisions. Given this situation, it is not surprising that the NSF summer institutes lent themselves to becoming a vehicle for implementation. It should be noted it could not be predicted in advance whether CHEM Study material, or chemistry as a topic, would be a subject for institute attention. Choice of material and the decision to submit a request were at the initiative of a given college or university. Grant awards were based on successful competition under the usual reviewing mechanisms.

It is fair to state that the primary focus of the institutes was on equipping teachers with adequate information about recent developments in chemistry and only secondarily on acquainting them with the approaches and materials developed by the CHEM Study program. Gradually, institutes adopted CHEM Study materials and as teachers became acquainted with the materials, they adopted them for use in classrooms around the country.

Newsletters and publications generated many requests for consultant assistance in adopting the materials as well as requests for their use in other privately sponsored institutes. Considering the experimental nature of this effort and the fact that methods of implementation are still a poorly researched area, the utilization of the new materials was surprisingly effective and rapid.

The Foundation recognized that in order for implementation to be more effective, the staff needed to devote more planning to this phase and to think more in terms of "targeted" audiences rather than to maintain generalized approaches. Borrowing from the experience of the National Council of Teachers of Mathematics, NSF concluded that developing the awareness of key administrative personnel through a series of conferences would be eligible for NSF support since they would be designed to encompass the breadth of curriculum reform in an area rather than focus on a single development supported by NSF.
than focus on a single development supported by NSF.

Except for this initiative, no other formal implementation mechanisms were considered for the CHEM Study Program.

Potential problem areas, policy issues and procedural matters requiring NSF attention

The basic NSF policies and procedures associated with receiving and reviewing proposals and with grants administration and monitoring appear sound. As NSF has entered new areas of activity, these have been modified or new procedures have been developed. Not unexpectedly, the changes have some times lagged behind the new activity. Areas for possible improvement in NSF procedures and policies suggested themselves. Of the following items, 1, 2 and 3 could pertain to all components of the Foundation. Item 4 is limited to the Education Directorate.

1) There are very explicit *conflict of interest statements* for NSF employees, Board members and ex-NSF employees who seek subsequent Foundation support. Should NSF establish guidelines and advise grantees as to similar considerations as they relate to contracts through the grantee which are let to former participants on a given project?

   The possible need was identified by a situation in which a major contract was let to a former project associate. The party had been disaffiliated from the project for more than a year prior to the contractual agreement. The act was executed with NSF approval. However, discussions and expression of interest on the part of the company had occurred within months of the resignation.

   Question: Should the Foundation establish guidelines which would preclude the 'appearance' of privileged status, conflict of interest, etc. for grantee contracts? Should there be a mandatory waiting period which precludes contracting with a participant for a defined period of time (there are obvious disadvantages to the Foundation in executing its responsibilities if the period is too long, i.e., does one become subject to penalization for participating)? In such cases, should there be a special third-party review?

   A similar situation involved a minor purchase order let to a former project participant, who subsequently became re-employed by the project.

   Question: In the interest of maintaining public accountability, what guidelines should NSF issue to grantees regarding such practices?

2) **Size of the award.** For most NSF grants the average size is such that annual progress reports are quite acceptable.

   Question: When the amount is large, e.g., in excess of $500,000/year, should NSF require quarterly or semi-annual reports? Should site visits by expert consultants be required to monitor progress? Should there be a requirement for an oversight committee? To what extent should internal reports of progress to Assistant Directors be required?

Any such policies should be flexible in that various installations require capital outlay or running costs well in excess of $500,000; such investments should be distinguished from the "project" grant and treated accordingly.

3) **Evaluation of progress.** The weakest link in the NSF system appears to be at this level. The general principles and procedures used are adequate and in fact quite sound. The correction lies in their improved application.

Two recent internal management innovations (Long Range Planning and Program Review) have helped in this respect, but they are at best periodic and generally limited to major developments or new directions.

This retrospective look leaves the clear impression that slippage in the monitoring of progress began to occur after the mid-sixties, during the period when staff increases did not keep pace with increased program responsibilities. (The same may be true in other NSF Directorates). In view of the heightened interest of Congress in NSF matters and the resulting additional demands on staff time, improvement in this area should probably be a number one NSF priority.

This would appear to require developing a strong case for increased staffing, consultant and travel money or for other changes in management emphasis. It is not clear how to devote more time to monitoring progress and improve monitoring and evaluation without additional resources.

4) **Materials developed in course improvement projects.** Depending on an individual program director's interests, these may get greater or lesser attention and review.

Question: Should there be a formal NSF review, including third party experts? It is important to avoid censorship, but perhaps the Foundation should have more systematic procedures for examining and reviewing materials.

SCIENCE CURRICULUM IMPROVEMENT STUDY (SCIS)

Science Curriculum Improvement Study (SCIS); *University of California, Berkeley;* $4,326,395 (Includes grant of $40,250 to University of Maryland); 1962-1977 (proposed); Grades K-6 (originally 1-6).

The SCIS project is focused on developing a framework of fundamental scientific concepts that are related to the student's own experience with natural phenomena. The attainment of this functional framework so that it provides a basis for assimilating further information is referred to as "scientific literacy."

Staff at the project headquarters at the Lawrence Hall of Science, University of California, Berkeley, include: the director, the assistant director, the director of Life Sciences, a coordinator, physicists, botanists, chemists, biologists, specialist teachers, research psychologists, laboratory assistants, production staff, research assistants, and secretaries. Also numerous consultants have contributed to the development of the SCIS program.

The Project Director is Robert Karplus, a nationally recognized research physicist. He obtained his doctorate at Harvard University in 1948; was a F. B. Jewett fellow at the Institute for Advanced Study at Princeton 1948-50; served as assistant professor of physics at Harvard for four years, moved to Berkeley as associate professor in 1954 and was appointed full professor in 1958. He has been a Guggenheim fellow and a Fulbright research grantee. He has spent one summer with the Elementary Science Study Project at Educational Services Incorporated (now Education Development Center, Inc.) in Massachusetts and one summer on the Minnesota School Mathematics and Science Teaching (MINNEMAST) Project at the University of Minnesota. During the year 1962-1963 he was on leave from Berkeley and served as a visiting professor of physics at the University of Maryland. Karplus originated the project and has been a driving force behind SCIS from its inception.

Herbert Thier, an experienced educational administrator and an early experimenter with the SCIS program, has been the assistant director of the project since 1963.

Chester A. Lawson, who left his position as research professor of natural science at Michigan State University in 1965 to construct the SICS life science program, served as director of development in the life sciences for SCIS until his retirement from the project in fall 1974.

The involvement of a commercial publisher began in June 1966 when D.C. Heath contracted with the University of California, Berkeley, to publish the preliminary editions of the SCIS program; American Science and Engineering, Inc., was selected as the apparatus manufacturer. In 1968, D.C. Heath decided that it no longer wished to publish the SCIS materials. On February 25, 1970 Rand McNally contracted with the University of California, Berkeley, to publish the final editions. All final editions except the kindergarten materials were published by 1972. The final edition of the kindergarten materials was published in 1974. Rand McNally retains exclusive rights to publish the SCIS materials until December 31, 1977, after which the entire program becomes free-licensed.

Trial Centers

To supplement the resources of the University of California at Berkeley, trial centers were established in New York at Teachers College, in Los Angeles at UCLA, at the University of Hawaii, at the University of Oklahoma, and in East Lansing at Michigan State University.

The trial centers serve as an experimental facility for SCIS and the cooperating institutions in four distinct but complementary ways. First, the additional experience with the use of the materials by a larger group of teachers and pupils tests the reliability of the procedures and the clarity of the communication with the teachers and pupils. Second, the in-service education activities in the trial centers serves as a pilot program for instructing teachers in the use of the SCIS curriculum. Third, all evaluation programs of the trial experience provide material for later studies. Fourth, each of the cooperating institutions associates the local trial centers in an appropriate way with its own educational activities.

These centers have been jointly supported by SCIS, the local university, and the local community. The centers operate their own programs with their local school districts, but are required to submit reports containing subjective teacher and student feedback on the SCIS materials.

Current Status

SCIS has developed ungraded, sequential physical and life science programs for kindergarten and elementary school. These programs involve 12 units for the elementary school and one unit especially designed for kindergarten. Each of these units has been carefully evaluated by SCIS staff as it progressed from the early exploratory stage to the final published edition. The units were also tested several times in elementary schools throughout the Nation before they were published.

The units, which include teacher guides and student materials are as follows: *Beginnings (kindergarten), Material Objects, Organisms, Interaction and Systems, Life Cycles, Subsystem and Variables, Populations, Relative Position and Motion, Environments, Energy Sources, Communities; Models: Electric and Magnetic Interaction, and Ecosystems.* The final units, together with evaluation supplements for each unit, were completed in the fall of 1974. These are available at cost from the Lawrence Hall of Science, University of California, Berkeley. A collection of six films depicting representative activities from both the SCIS Life Science Program and the Physical Science Program are available for rental or purchase from the University of California Extension Media Center, Berkeley, California.

The last date on which NSF funds were awarded to the SCIS project was September 26, 1972. NSF has extended the expiration date for the project to December 31, 1977, with no additional funds. This expiration date corresponds to the termination date of the exclusive rights of Rand McNally to publish SCIS materials.

The funding history for the SCIS project is given below.

SCIS FUNDING HISTORY

Grant	Award Date	Expiration Date	Award Amount
GE-600 (Univ. of Md.)	10/26/62	8/31/63	$40,250
GE-2914 (Berkeley)	9/23/63	8/31/64	99,480
Amendments to GE-2914			
1	6/18/64	6/15/65	75,000
2	8/25/64	6/15/65	154,300
3	6/30/65	10/31/65	199,910
4	10/1/65	6/30/67	300,000
5	9/13/66	6/30/67	552,000
6	6/29/67	9/30/70	176,000
7	1/12/68	9/30/68	635,000
8	6/28/68	9/30/69	625,000
9	6/30/69	9/30/71	1,171,000
10	6/29/71	6/30/73	138,455
11	6/26/72	6/30/73	160,000
12 (Extension of expiration date to September 30, 1974)			0
13 (Extension of expiration date to December 31, 1977)			0
Total			$4,326,395

Description of the SCIS Materials

Organization of Materials

The SCIS program consitst of 13 units, six units for a physical science sequence, six for a life science sequence, and one unit, subsequently, dropped, designed especially for kindergarten. The unity of the physical science sequence derives from fundamental concepts of change and interaction. The six basic physical science units—*Material Objects, Interaction and Systems, Subsystems and Variables, Relative Position and Motion, Energy Sources, and Models: Electric and Magnetic Interactions*—are designed to introduce and develop the concepts considered necessary for scientific literacy. In the life science sequence the units focus on organism-environment interaction. The six basic life science units—*Organisms, Life Cycles, Populations, Environments, Communities, and Ecosystems*—make use of many scientific concepts, but focus on the special considerations appropriate to the study of life. The Ecosystems unit attempts to synthesize children's investigations in physical and life science. The kindergarten unit, *Beginnings* was designed to develop children's powers of observation, discrimination, and description.

The following table shows the seven levels of the SCIS program along with the concepts introduced in each unit. Either the physical or life science program may be used independently. Within the physical or life science programs, the units are designed to be sequentially presented, rather than as independent modules or components. Each sequence of the six elementary units roughly corresponds to the 1-6 grade level sequence.

Format of Materials

The SCIS materials reach the classroom in the form of kits. The kits are designed to simplify and make convenient the use, storage, and re-use of the required equipment and supplies. Each kit is packaged for a teacher and 32 children and contains all of the materials needed except standard classroom supplies, such as crayons and scissors, and the fresh-water organisms which are sent separately when requested by the teacher. Each unit contains a teacher's guide and a student manual. The teacher's guides include the following:

1. An explanation of the conceptual framework for SCIS.
2. An overview of the particular unit or sequence.
3. Suggestions for the teacher—explanation of the learning cycle, exploration/invention/discovery; how to implement the learning cycle; use of discussions, questions and feedback; the student manual; language development; and optional activities.
4. Design and use of the kit.
5. Major parts of the unit—series of chapters are combined to form parts of the unit. Preceding each series of chapters there is a list of objectives for that part of the unit, background information, an overview, and how the student manual can be used.
6. For each chapter, learning objectives, teaching materials needed, advance preparation required, teaching suggestions, and optional activities are described or noted.

The Kindergarten and Six Levels of the SCIS Program
With Major Concepts Introduced in Each Unit

Kindergarten Level	*Beginnings*			
	color shape texture	odor sound size	quantity position organisms	
	LIFE SCIENCE *Organisms*		PHYSICAL SCIENCE *Material Objects*	
Level 1	organism birth death	habitat food web detritus	object property material	serial ordering change evidence
	Life Cycles		Interaction and Systems	
Level 2	growth development life cycle genetic identity	biotic potential generation plant and animal metamorphosis	interaction evidence of interaction	system interaction-at-a-distance
	Populations		*Subsystems and Variables*	
Level 3	population food chain plant eater animal eater	[illegible]	subsystem evaporation histogram	solution variable
	Environ[illegible]		*Relative Position and Motion*	
Level 4	environment environmental factor	range optimum range	reference object relative position relative motion	polar coordinates rectangular coordinates
	Communities		*Energy Sources*	
Level 5	photosynthesis community food transfer raw materials	producers consumers decomposers	energy transfer energy chain	energy sources energy receiver
	Ecosystems		*Models: Electric & Magnetic Interactions*	
Level 6	ecosystem water cycle food-mineral cycle	oxygen-carbon dioxide cycle pollutant	scientific model magnetic field	electricity

The student manual is used as a teaching aid and is not designed as a mainstay of the unit. During some activities, the students record certain information about their experiments in their manual, for later discussion. The manual also contains some problems for students to solve independently, and some for class discussion.

Cost of Materials to User

Each complete kit includes equipment and consumable materials for the teacher and 32 students. In both the physical science and the life science units some materials and living organisms will be consumed during first use and must be replaced each time the course is taught. Also some of the units can be shared by two or more teachers. Each complete kit (1974 prices) costs between $125 and $280. Refill packages cost between $8.00 and $60.00 A complete set of the level K-6 SCIS kits would cost approximately $2,700.

Procedures for Using the Product

Student Activities

The SCIS program is designed to foster direct laboratory experiences for the student. The elementary classroom actually becomes a laboratory. In their first explorations of a new concept, the students manipulate or observe selected materials, sometimes freely, sometimes under the guidance of the teacher.

The SCIS units are designed so that students can complete one unit per semester, or two per school year, provided they spend at least 45 minutes per day, two days per week working on the units. While the objectives for each student activity are well specified in the teacher's guide, these objectives are never presented to the student. SCIS developers felt that presenting the student with the objectives would hinder the explorational and experimental aspects of learning. Students obtain feedback through group discussions and interactions with the teacher. Motivation for the student is primarily intrinsic, e.g., working with live animals and real objects.

Teacher Activities

The effective SCIS teacher is a leader whose job is not simply to tell children about science or to listen to them while they read about science, but rather to observe and provide guidance to students while they are individually involved with science. The teacher uses the students' work, observations, and questions as a basis for planning subsequent science activities. The SCIS teacher should be sensitive to the student's pregress or lack of it, and respond in a manner that enables the student to move ahead. The teacher provides conceptual "inventions," but these are always followed by extensive opportunities for student centered "discovery" experiences.

The role of the teacher differs, depending on which stage of the three phase teaching/learning cycle is emphasized. *Exploration* requires that the teacher remain in the background, observing and occasionally answering questions. During *invention*, the teacher is more active. During *discovery*, the teacher's role is primarily to ask facilitating questions and to respond to student questions in ways that stimulate further inquiry.

To teach the SCIS programs effectively, the developers recommend that the teacher should have sufficient background understanding of science and the SCIS program to move with students along divergent, as contrasted to the more usual, narrowly focused paths. A strong emphasis upon in-service teacher training has been maintained by the developers at SCIS headquarters in Berkeley and at the SCIS trial centers. Also in-service training programs, such as SCIS Awareness Conferences, Cooperative College-School Science Programs, and Summer Leadership Training Programs, have been conducted.

History of SCIS Development*

During the late 1950's, following the launch of Sputnik, numerous meetings of educators and scientists were held throughout the Nation to discuss the adequacy of the high school science curriculum. Dr. Robert Karplus, Professor of Physics at the University of California at Berkeley, attended several of these meetings and was impressed by the complaints made by the high school science teachers present. These teachers were irritated and concerned by how unprepared in science their students were when they entered high school.

At this time, Karplus was becoming reacquainted with the public schools. Two of his children were in the early elementary grades and there was a desperate need at their school for someone to help in the teaching of science. Karplus was invited by the school to participate in "show and tell" sessions, and found this participation to be a very rewarding experience.

After hearing the high school teachers' concerns about inadequate preparation of students and having personally taught in elementary school classrooms, Karplus concluded that there was a great need for improvement of science instruction at the elementary level. Therefore, in the summer of 1958, Karplus and a group of colleagues at Berkeley submitted a proposal from the Orinda Union School district to NSF entitled "A Proposal for Research and Action in the Field of Elementary School Science Teaching in the Orinda Union School District." Orinda is located near the U.C. of Berkeley campus. The proposal requested $150,000 for the period April 1959 through June 1962.

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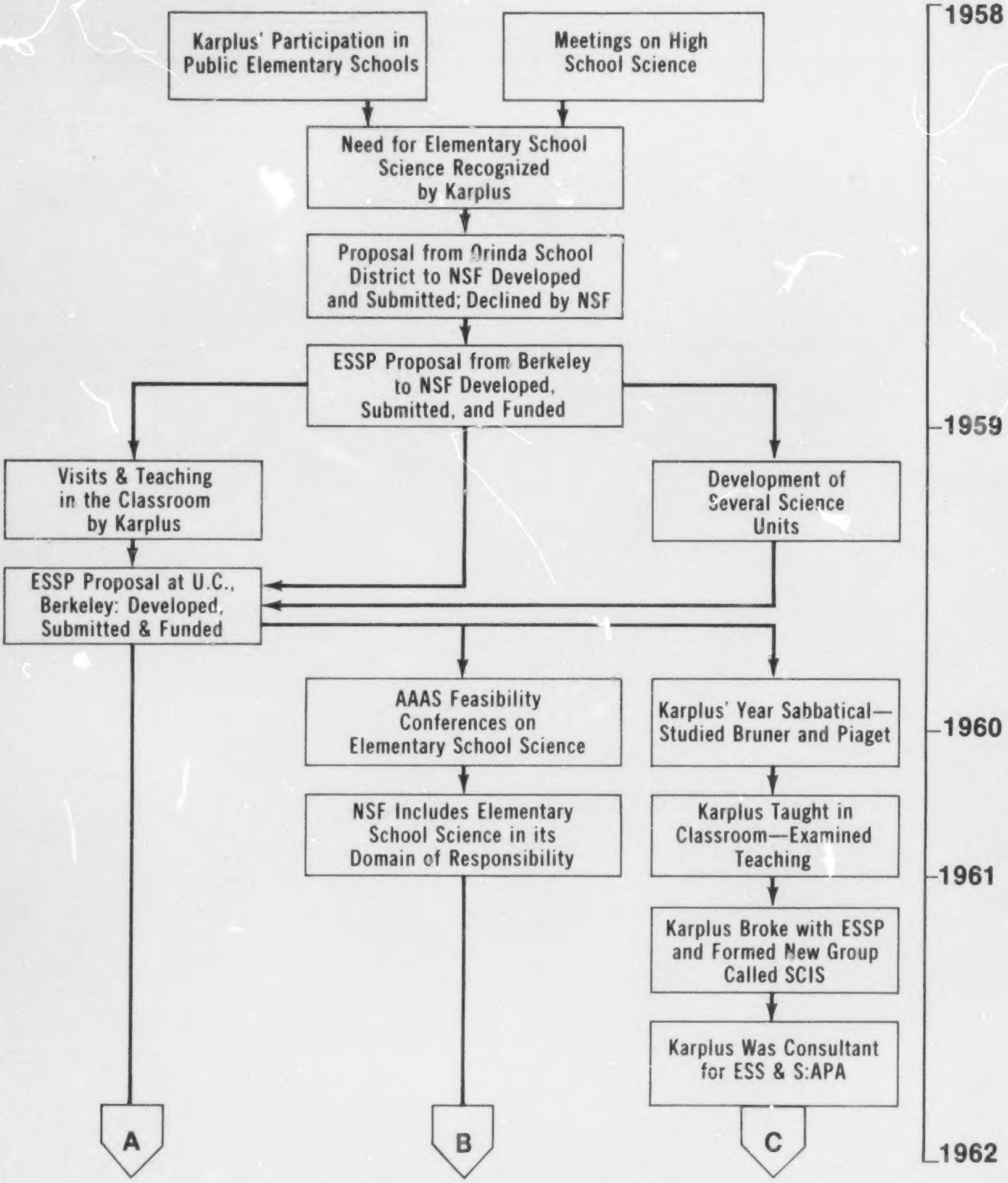
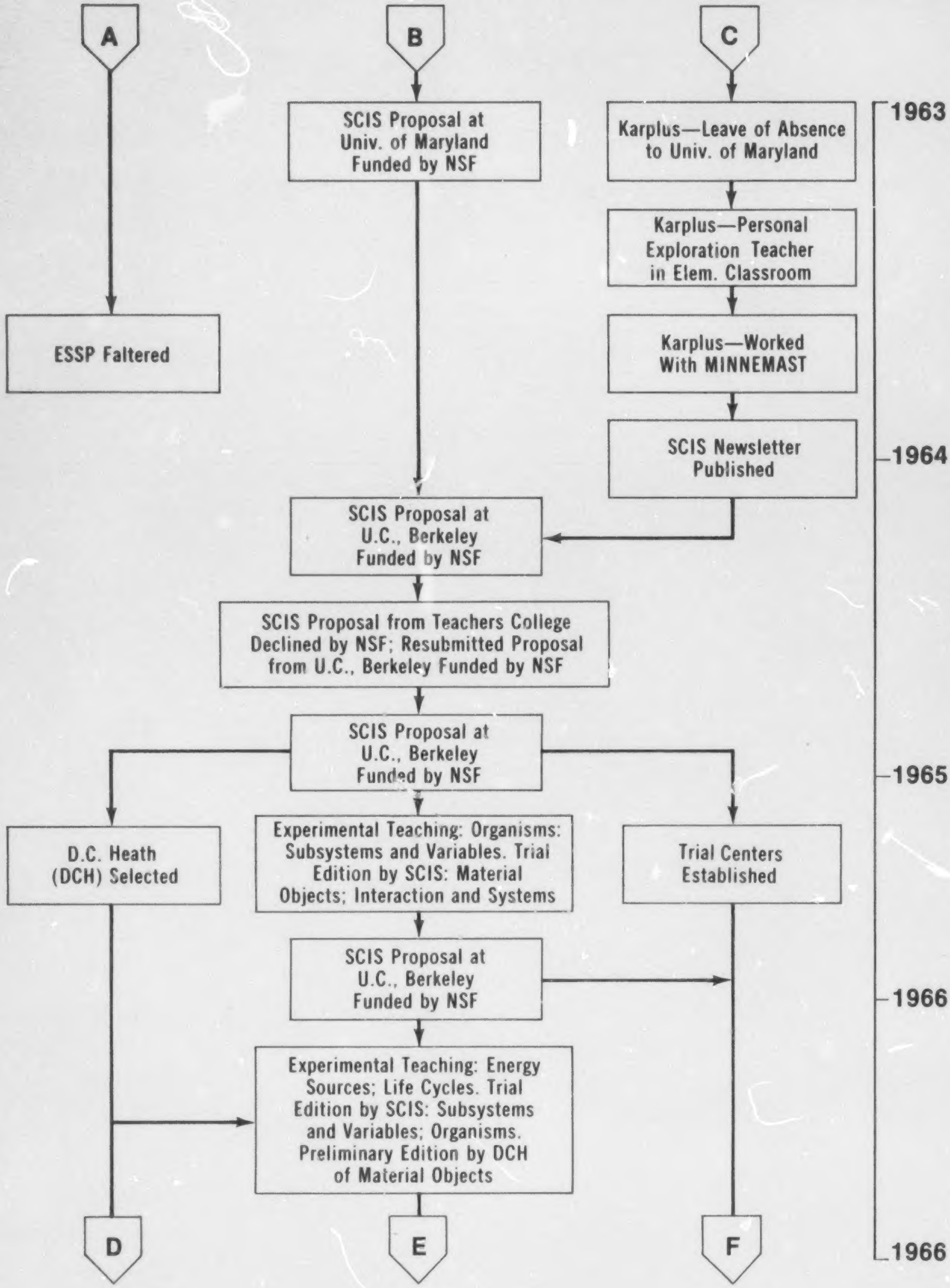
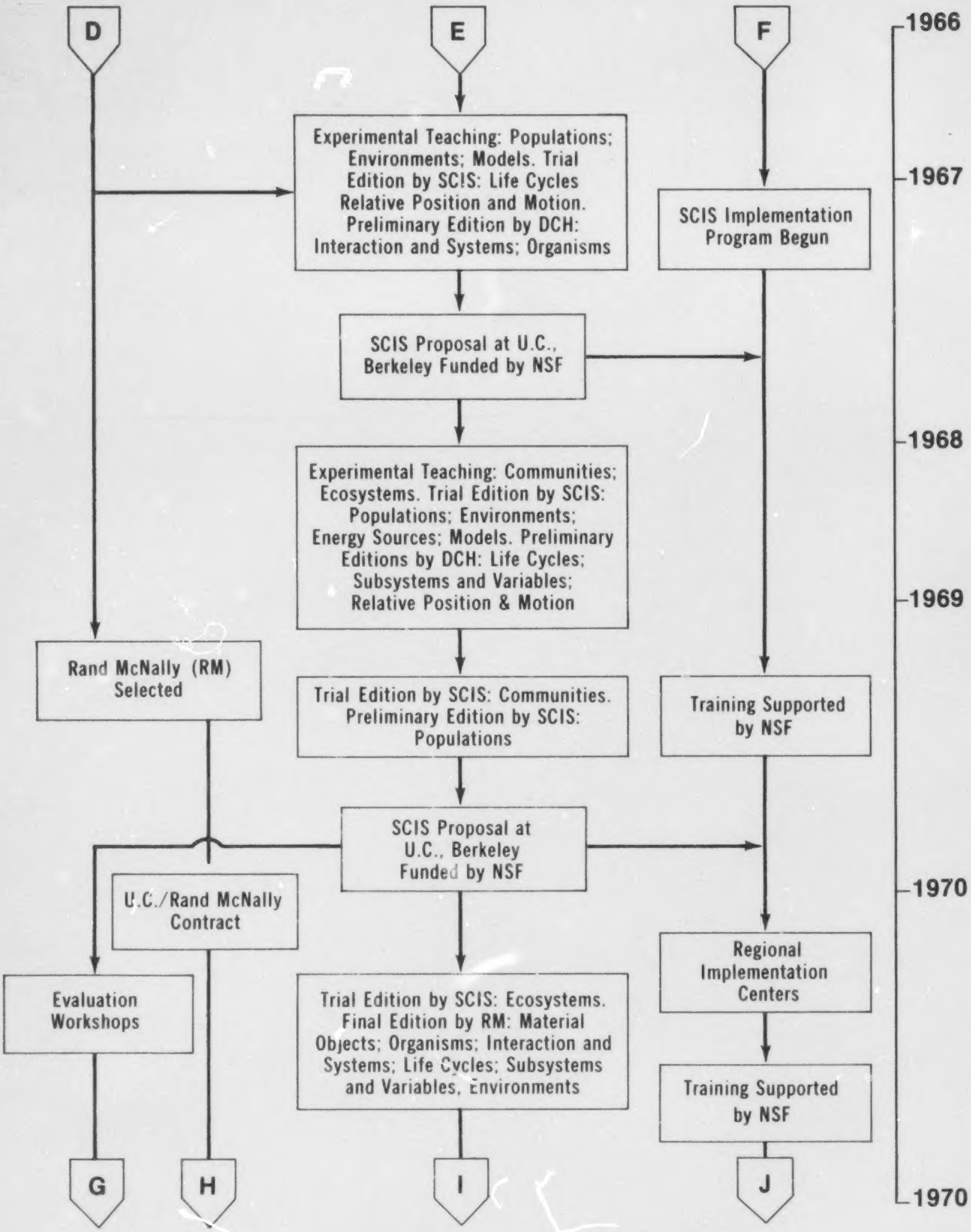
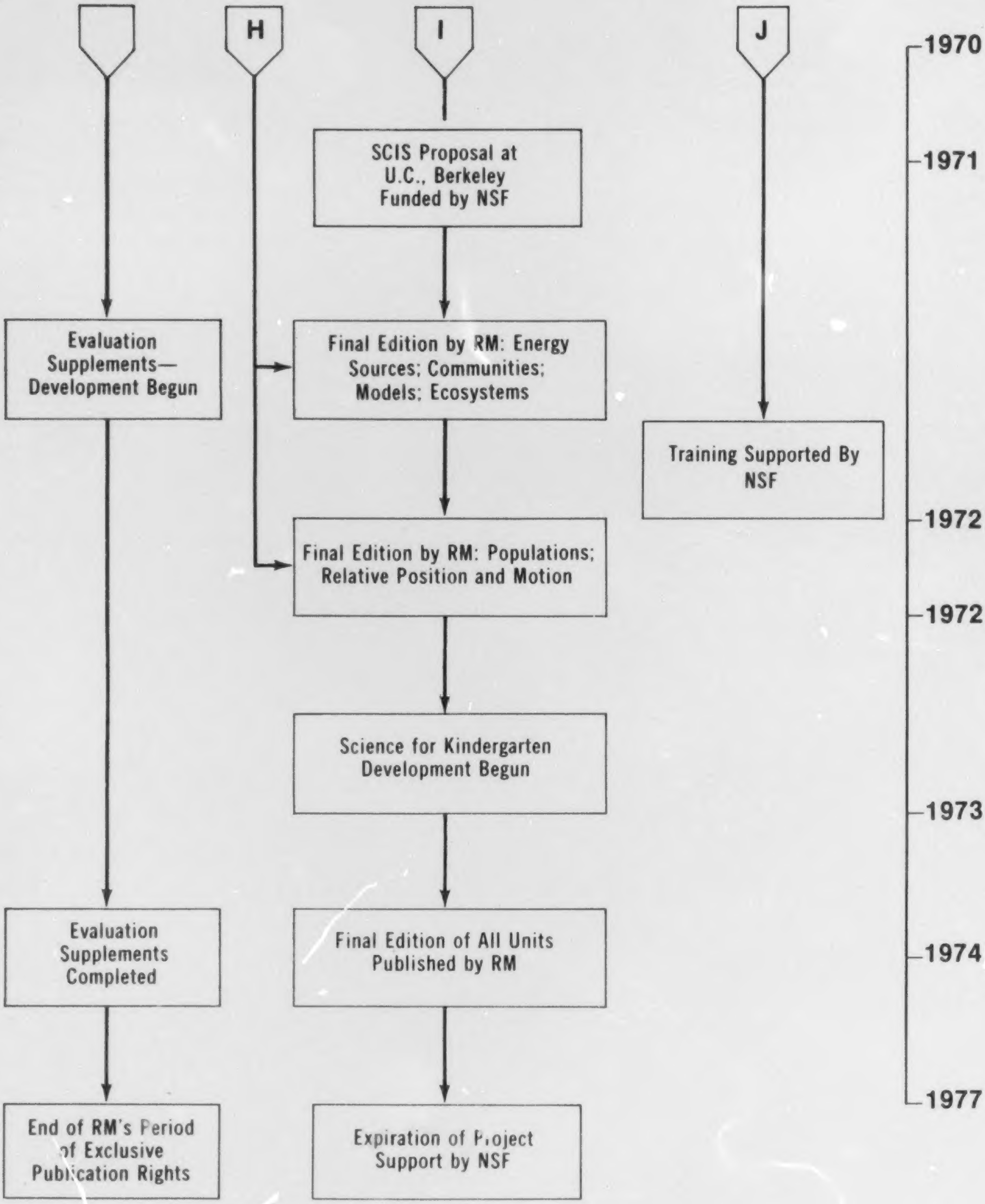
* See Figure I for a flow diagram of the major events in the history of the SCIS project.

MAJOR EVENT FLOW CHART


Karplus' Participation in Public Elementary Schools
Meetings on High School Science
Need for Elementary School Science Recognized by Karplus
Proposal from Orinda School District to NSF Developed and Submitted; Declined by NSF
ESSP Proposal from Berkeley to NSF Developed, Submitted, and Funded
Visits & Teaching in the Classroom by Karplus
Development of Several Science Units
ESSP Proposal at U.C., Berkeley: Developed, Submitted & Funded
AAAS Feasibility Conferences on Elementary School Science
Karplus' Year Sabbatical—Studied Bruner and Piaget
NSF Includes Elementary School Science in its Domain of Responsibility
Karplus Taught in Classroom—Examined Teaching
Karplus Broke with ESSP and Formed New Group Called SCIS
Karplus Was Consultant for ESS & S:APA
A
B
C
1958
1959
1960
1961
1962


A
B
C
SCIS Proposal at Univ. of Maryland Funded by NSF
Karplus—Leave of Absence to Univ. of Maryland
Karplus—Personal Exploration Teacher in Elem. Classroom
ESSP Faltered
Karplus—Worked With MINNEMAST
SCIS Newsletter Published
SCIS Proposal at U.C., Berkeley Funded by NSF
SCIS Proposal from Teachers College Declined by NSF; Resubmitted Proposal from U.C., Berkeley Funded by NSF
SCIS Proposal at U.C., Berkeley Funded by NSF
D.C. Heath (DCH) Selected
Experimental Teaching: Organisms: Subsystems and Variables. Trial Edition by SCIS: Material Objects; Interaction and Systems
Trial Centers Established
SCIS Proposal at U.C., Berkeley Funded by NSF
Experimental Teaching: Energy Sources; Life Cycles. Trial Edition by SCIS: Subsystems and Variables; Organisms. Preliminary Edition by DCH of Material Objects
D
E
F
1963
1964
1965
1966
1966


D
E
F
1966
Experimental Teaching: Populations; Environments; Models. Trial Edition by SCIS: Life Cycles Relative Position and Motion. Preliminary Edition by DCH: Interaction and Systems; Organisms
1967
SCIS Implementation Program Begun
SCIS Proposal at U.C., Berkeley Funded by NSF
1968
Experimental Teaching: Communities; Ecosystems. Trial Edition by SCIS: Populations; Environments; Energy Sources; Models. Preliminary Editions by DCH: Life Cycles; Subsystems and Variables; Relative Position & Motion
1969
Rand McNally (RM) Selected
Trial Edition by SCIS: Communities. Preliminary Edition by SCIS: Populations
Training Supported by NSF
SCIS Proposal at U.C., Berkeley Funded by NSF
U.C./Rand McNally Contract
1970
Regional Implementation Centers
Evaluation Workshops
Trial Edition by SCIS: Ecosystems. Final Edition by RM: Material Objects; Organisms; Interaction and Systems; Life Cycles; Subsystems and Variables, Environments
Training Supported by NSF
G
H
I
J
1970


H
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1970
SCIS Proposal at U.C., Berkeley Funded by NSF
1971
Evaluation Supplements—Development Begun
Final Edition by RM: Energy Sources; Communities; Models; Ecosystems
Training Supported By NSF
1972
Final Edition by RM: Populations; Relative Position and Motion
1972
Science for Kindergarten Development Begun
1973
Evaluation Supplements Completed
Final Edition of All Units Published by RM
1974
1977
End of RM's Period of Exclusive Publication Rights
Expiration of Project Support by NSF

In this proposal Karplus proposed to conduct experiments with the content, methods, and materials for elementary school science with the aim of establishing a comprehensive curriculum; to develop in-service training programs for Orinda teachers; and to identify gifted students. The proposal was declined by NSF. At that time, NSF felt that its support should take the form of a national effort developed by the scientific community to improve school curricula and programs, such as the summer institutes for teachers sponsored by colleges and universities.

The NSF felt that it would be wise to wait until a comprehensive curriculum program had been formulated before considering small-scale variants like the one proposed by Karplus. Furthermore, up to this time NSF had only provided support to universities or colleges and did not entertain proposals from local school districts.

In the spring of 1959, Karplus submitted another proposal to NSF through the University of California at Berkeley, rather than through a school district. The "Proposal for a Study of Course Content Improvement in Elementary School Science," suggested a duration from July 1959 through June 1960, and requested total funds of $43,000. The project was funded and appears to be the first NSF direct support for an elementary school science project. The project became known as the Elementary School Science Program (ESSP). It proposed to construct a conceptual framework for the elementary science curriculum, to prepare sample teaching units, to conduct an evaluation of the effectiveness of the materials, and to adopt the materials for use in training teachers.

In June 1960, Karplus left for a sabbatical at the University of Vienna. During his stay in Vienna, Karplus read several books and articles by Bruner and Piaget and began to reformulate his thinking about science education.

In June of the same year, NSF made an award of $58,310 to the American Association for the Advancement of Science (AAAS) for the purpose of holding a series of conferences to explore the feasibility of a major effort to improve science courses in elementary and junior high schools. Three regional conferences of about fifty persons each were held in St. Louis, Missouri in January 1961; in Berkeley, California in February 1961; and in Washington D.C. in March 1961. Participants included scientists, leaders in education, and elementary and junior high school teachers. During these conferences, it was concluded that a major effort should be undertaken and that this effort should involve both course materials and classroom teaching. Recommendations were made that NSF support development of two or three major elementary and junior high science programs in the U.S. These recommendations were published and widely circulated in an article in Science magazine, in 1961.

Meanwhile, the ESSP continued at Berkeley under the interim direction of Karplus' colleagues, subject to certain understandings between NSF, the University Chancellor, and Karplus. However, after his return to Berkeley in the fall of 1961, Karplus felt that the direction of the ESSP project had been altered without his knowlecge. He felt that the project had taken an unpromising course that threatened to prevent his continuing according to his own ideas. It appears that Karplus' colleagues believed that personal classroom participation by the product developers was neither essential nor desirable, and Karplus held strongly to the opposing view.

Although NSF had provided funds for ESSP to continue during the 1961-62 school year, Karplus felt that he should start his own independent activities. By the winter of 1962, he had completely dissociated himself from ESSP and had formed a new group called the Science Curriculum Improvement Study (SCIS).

By the fall of 1961, NSF had officially included support for elementary school science in its domain of responsibility. By the summer of 1962, NSF had granted substantial funds to the Elementary Science Study (ESS) and Science: A Process Approach (S:APA). These were two major science projects resulting from the AAAS feasibility conferences.

Apparently recognizing the need to reinforce the separate identity of the SCIS group, Karplus took a leave of absence from the University of California at Berkeley and placed the SCIS headquarters at the University of Maryland where he was a visiting professor of physics during 1962-63. NSF provided funds for the project at Maryland in the amount of $40,250. Karplus used the year at Maryland to continue his exploration and teaching of young children in the elementary schools. At this time no SCIS units or products were being planned or developed.

The MINNEMAST project was funded by NSF in the winter of 1963 and became the third major elementary school science program. Karplus was invited to serve as Director of Science for this project for the summer of 1963 which allowed him to further develop and try his ideas. In the fall of 1963, Karplus returned to Berkeley and received an NSF grant for $99,480 to continue his work on SCIS. At this time the ESSP project at Berkeley was faltering and apparently presented no obstacle to the efforts of SCIS. Also, by this time NSF had been supporting Karplus' exploratory work for four years and now wanted him to either plan on phasing out his exploratory work and expect no more NSF funds, or to put the SCIS project on a larger scale with a more permanent footing and with clearly specified plans to produce materials. No SCIS materials had been produced since those originally developed in 1959. Karplus chose the second alternative and the SCIS project moved from an exploratory investigation to product development.

Senior scientists, personally committed to curriculum experimentation and materials production, were providing leadership to the project. A conceptual structure of science was chosen to provide the framework for the curriculum plan. The new materials were being tried in schools with teachers and children who were to participate in the development year after year. This development begun in the fall of 1963 was completed, after several revisions, by fall, 1974. Final editions of all 12 units (excluding the kindergarten units and evaluation supplements) were published by 1972.

In December 1964, a proposal for support of the SCIS project was submitted by Teachers College of New York. Karplus was listed as a consultant to the project and also as the director. Apparently Karplus felt that he would be able to get more and better support in the tryout and evaluation phases of his work from Teachers College of New York, than he could get at Berkeley. It appears that he also felt that Teachers College staff involvement would be greater if the institution actually held the grant rather than merely acting as a source for an occasional consultant.

The proposed arrangement was approved by both Teachers College and the University of California at Berkeley. Karplus was to continue as director of the project while maintaining his headquarters at Berkeley. It was proposed that reimbursement for services provided by the University of California be made by purchase orders to Teachers College.

The Foundation declined to support this proposal, mainly because of the unusual administrative and business practices it entailed. However, in July 1965 the NSF received a resubmitted proposal for continuation of the SCIS project through the University of California at Berkeley. This proposal included establishment of four trial centers to assist in testing of SCIS materials and, with this additional provision, was funded.

The SCIS project staff has spent much time on product development. From the early 1960's to the early 1970's development of each SCIS units involved four major phases—early experimental teaching, trial edition, preliminary editions and final editions. On page 87 is a summary outline indicating when these phases took place for each of the 12 SCIS units (excluding the kindergarten unit).

Analysis of Impact

The SCIS units and materials are presently being used to some extent in almost all states. Estimates of student usage based on the publisher's (Rand McNally and Co.) sales data indicate that more than one million students or approximately 3 percent of the elementary school population are now using the SCIS program. These students come from every socioeconomic level and are in both rural and urban school districts. The SCIS program has also been adopted and modified for use by blind children. It is anticipated that by 1977 a minimum of 15 percent of the school-aged population will have been exposed to SCIS materials.

The future of the SCIS program will depend on: (1) whether or not school personnel are willing to spend a larger share of their limited funds on elementary school science; and (2) whether or not the teachers who will use the program are effectively trained. The major impact of the program is expected to be in the traditional classroom.

Review and Oversight History

From 1959 through December, 1970, formative evaluation, designed to determine the appropriateness of the SCIS science materials, was

	Units	Early Experimental Teaching	Trial Editions Published	Preliminary Editions Published	Final Editions Published
1.	Material Objects	1962-63	Nov. 1963; Sept. 1964; Aug. 1965	June 1966	March 1970
2.	Organisms	1964-66	Sept. 1966	June 1968	May 1970
3.	Interactions and Systems	1961-63	Oct. 1963 March 1966	July 1967	May 1970
4.	Life Cycles	1965-67	Sept. 1967	1968	Nov. 1960
5.	Subsystem and Variables	1964	Sept. 1964 Feb. 1966	1968	Oct. 1970
6.	Populations	1966-67	March 1968	1969	July 1972
7.	Relative Position and Motion	1961-64	Jan. 1964; Nov. 1966; Sept. 1967	1968, 1969	May 1972
8.	Environments	1967-68	Sept. 1968	None	Nov. 1970
9.	Energy Sources	1962-64	Jan. 1965; Sept. 1966; Sept. 1967; Feb. 1968; Sept. 1969	None	June 1971
10.	Communities	1967-69	Oct. 1969	None	July 1971
11.	Models	1966-68	Sept. 1968	None	Aug. 1971
12.	Ecosystems	1968-1969	Feb. 1970	None	Aug. 1971

conducted by the project staff.

Ideas for each SCIS unit were first discussed by the project staff, and through extensive formative evaluation procedures these ideas were translated into the activities, materials, and equipment for the units. The evaluation activities for each unit generally moved from discussion and testing of the exploratory version to classroom trial, revision, and retrial. Public schools in Berkeley, California, as well as several schools affiliated with the SCIS trial centers provided feedback into this process.

The information collected during the formative evaluation activities helped to determine which units were interesting to students, which were appropriate to the students' level, and which were producing the intended learning outcomes. On the basis of this feedback, SCIS materials and equipment were revised and redesigned. Some units were completely or partially rejected, while others were integrated into other units.

In the spring of 1970 NSF supported a SCIS evaluation workshop, during which various feedback activities were compared and a multiphasic approach to evaluation was designed to focus on content and process gain, intellectual developmental stages, interests and attitudes, and teacher self-images in SCIS instruction.

The development of evaluation supplements for the SCIS units were begun in the spring of 1971 and completed in the fall of 1974. The main purpose of these supplements is to serve the teachers if they need external assistance to evaluate student performance.

The SCIS staff has not and does not plan to conduct a large-scale long term summative evaluation program. However, NSF does have plans for a summative evaluation of the SCIS project to be conducted by an independent third party beginning in 1977.

Monitoring History

In the early history of the SCIS project there appeared to be no regular pattern for NSF staff monitoring. Major interactions between NSF and SCIS staff appeared to have taken place only directly following the NSF receipt of annual SCIS proposals or when significant plans were suggested by SCIS to revise the budget.

In 1969 NSF engaged three consultants to perform a substantive review of SCIS materials and procedures. The results of this review were used to provide critical input to the SCIS project director.

NSF personnel approved the selection of all publishers/distributors for SCIS materials and agreed to all contractual arrangements between

SCIS (U.C., Berkeley) and the publishers/distributors. It appears that the selection of a publisher and the contractual arrangements followed sound business and legal practices.

Dissemination/Implementation Plan

Interest in implementing the SCIS program in local school systems usually evolves through reading of the literature by school personnel, convention presentations, or interactions with neighboring school systems. Based on discussions with members of the SCIS project staff and/or the commercial distributors for SCIS, an overall plan for the long term implementation of the program in a local community generally includes the following characteristics:

1. A commitment is obtained from one or more school leaders to take responsibility for general administration, obtaining funding, making provisions for the necessary training, and identifying themselves with the SCIS program.
2. A pilot run of the program in the school system is then made to determine whether to proceed with large-scale implementation.
3. Key individuals from the local school system are selected by school authorities to carry on the leadership of the teacher education activities. Presently, such individuals are invited to attend the SCIS Implementation Program at Berkeley for a period of one week. Each one-week study visit is tailored to the interests and needs of the participant. The visitors participate in discussions with SCIS members, visit classrooms, and receive training on specific techniques for working with teachers in their own school districts.
4. These teacher trainees then return to their local school districts and begin the task of training local teachers.

In the late 1960's NSF funded numerous cooperative projects at universities for conduct of intensive summer training activities for teachers to include follow-up in-service assistance during the academic year. Some Cooperative College School Science (CCSS) projects were designed to train teachers to conduct SCIS classrooms. Another dissemination activity involved the publication of the SCIS Newsletter which presently is published quarterly and currently reaches more than 25,000 readers annually.

In the summer of 1974, the NSF funded implementation projects throughout the country in the use of SCIS and other elementary science programs. Thirty-one of these projects, with 1,600 participants, were devoted exclusively to SCIS, its materials, concepts, philosophy, and teaching methods. Another forty-five projects, with over 8,000 participants, dealt with SCIS along with other NSF-supported programs.

Problems Suggested by Detailed Review

1. There was an apparent lack of sensitivity on the part of NSF concerning selection of reviewers; there were no clearly delineated criteria for reviewer selection.
2. Because of the highly interdisciplinary nature of the proposed SCIS project and its implication for change in schools on a national basis, the mail review system does not appear to be the best system for proposal evaluation.
3. There appear to be no specific provisions for parent involvement in the development and implication of SCIS.
4. In the early history of the project, NSF had no well-defined system for monitoring or evaluating its progress; appointment of outside consultants by NSF helped correct this deficiency.
5. The costs for fully implementing the SCIS program on a wide-scale, including costs for teacher training and the SCIS kits, are generally higher than most school districts are able and willing to pay for elementary school science.
6. Many schools are not prepared to handle and organize all of the SCIS materials, especially the live plants and animals.
7. More coordination is suggested in monitoring all approaches to elementary science curricula. During early support of SCIS, NSF was also involved in the Elementary Science Study (ESS); Science: A Process Approach (S: APA); the Minnesota

Mathematics and Science Training (MINNEMAST) project; and the Elementary School Science Project (ESSP). From 1958 to 1968 approximately 16 coordinating conferences involving the project leaders of all the NSF course and curriculum improvement projects were held. While there apparently were a number of coordination efforts carried out by NSF, there is still a question of exactly what role the Foundation should play in coordinating its curriculum efforts to minimize duplications and maximize effectiveness.

COMPARING POLITICAL EXPERIENCES (CPE)

Political Science Course Content Project for Elementary and Secondary Schools - "Comparing Political Experiences"; *American Political Science Association, Washington, D.C.;* $1,261,900; 1970-continuing; Grades originally K-12; presently 10-12

The Political Science Course Content Improvement Project as proposed by the American Political Science Association (APSA) consisted initially of two components. One, the High School Political Science Curriculum Project, was to develop instructional materials for use in senior high school civics and government courses. The other, for elementary schools, undertook a study of political science education in elementary schools and, on the basis of this study, developed a set of guidelines for the production of new instructional materials and media for grades kindergarten through six.

The materials produced by the high school project will be conceptually oriented, interdisciplinary in content, and will focus upon perennial problems and universal experiences in the political life of mankind. They are being designed for use either in conjunction with existing curricula or as new programs in political science education.

In early 1975, the decision was made by NSF to discontinue support of the elementary school project after the first year. The high school project material was in tryout in 1974 and second semester material is in preparation.

Products to date include:

First semester—Experimental version of teacher and student materials

Unit I: Politics Here and Now

Unit II: Political Resources

Unit III: Political Activities

Unit IV: Four Political Experiences

Second Semester—40 Page Outline

The exact nature of publication is not yet determined. It may be one hard cover textbook or a series of separate units.

Development

As early as 1963, when the determination was made that political science was potentially appropriate subject material for the Foundation, the Director concluded that political science contained elements that were objective, verifiable, and susceptible to generalization. He further concluded that political science now employs—and essentially to the same degree—a "scientific" methodology similar to economics or sociology.

In April 1970, the American Political Science Association (APSA) established a committee on pre-college education to consider how instruction on government and politics in elementary and secondary schools could be improved. The committee's report, "Political Education in the Public Schools: The Challenge for Political Science", proposed substantial reforms. The premise of the report is that the treatment of political science in traditional social studies texts is seriously inadequate, that alternative curriculum material does not exist and must be developed. The report was based on results of small-scale surveys of students, teachers, and curriculum specialists.

This report was part of the APSA proposal received by the Foundation on September 22, 1971, after a July 1, 1971, inquiry from APSA and a July 27, 1971, meeting between NSF and APSA staff. The grant was awarded March 13, 1972. The Project Director is Dr. Howard D. Mehlinger, Director, Social Studies Development Center, Indiana University. He had produced a text on "American Political Behavior", published by Ginn & Company, available in the summer of 1971 and copyrighted in 1972. The Co-Director is Dr. Richard C. Snyder, Director, Mershon Center for Education in National Security, Ohio State University.

Analysis of Impact

Presently, there are twenty-five pilot schools using the course material. There are also fifty affiliate schools which receive the materials but are only informally involved in the pilot testing, i.e., the schools are free to use the material and may or may not provide feedback to the Project Director.

At this time, no projection of ultimate use has been made nor is there any body of opinion from the professional community on the material save reviewers' comments generally favoring the material and recommending support.

Review History

The American Political Science Association was responsible for verification of the accuracy of scientific content as part of its activities in monitoring curriculum development. At later stages, comments were received after some portions of the material were distributed to reviewers or summarized in renewal proposals.

Judging from comments of reviewers, the co-project directors were found to be highly qualified professionals and there were no questions of their competency. Both were on the staff of academic institutions, Indiana University and Ohio State University, and had served respectively as Chairman and member of APSA Committees on Pre-Collegiate Education.

Although no conflict of interest appears to exist in fact, the practicability of the prime grantee making the sub-awards to Indiana and Ohio may be questionable from a managerial viewpoint.

Monitoring History

No site visit was made prior to the award of the grant in March, 1972. A site visit was later made to Indiana University at Bloomington on June 21-22, 1973. The availability of project personnel, requirements for schools and training of trial teachers were discussed.

Interaction between NSF and project staff is generally in reaction to communication from the Project Director. Extensive program monitoring is not a practice followed by the program office, but today's monitoring process represents a decided improvement over that employed in the early 1960's. Possibly because this project is in its early stages, there has been greater continuity on the part of the NSF program office and reasonable attention has been given to monitoring the program.

It is apparent that the basic philosophy for curriculum development monitoring is that major reliance is placed on the highly qualified project directors selected. Not unlike review activities on other grants, major reviews have occurred annually when requests for additional funds are received.

No specific oversight committee was appointed by the Foundation. The fact that the American Political Science Association was the grantee and had responsibility for overall coordination of the effort appears to have led to the conclusion that the need for such a function was met.

Page three of the proposal (on file) provides background information on the oversight committee appointed by APSA. Since APSA represents the scientific discipline involved, a question could be raised whether it would not have been appropriate to have an oversight committee independent of the professional society if it were possible to obtain qualified participants.

Dissemination/Implementation Plan

Indiana University held a publishers conference in July of 1974 to present four projects of the Social Studies Development Center to potential publishers. The University was furnished a copy of the Foundation's publication policy. This requires approval of plans to announce the availability of materials to all qualified distributors as well as approval of the selection of a particular publisher; and finally approval of the proposed contract between the publisher and the grantee. The University plans a second conference in the fall of 1975 to present more definitive material at which time it will invite specific proposals from publishers. The dissemination and implementation plan has not yet been fully developed, but it appears that it will conform to NSF requirements.

Problems Suggested by Detailed Review

1. In 1972, the practice was that a professional association determined a curriculum need through a self-appointed committee. The APSA committee chairman and a member, then concluded that it would be appropriate for the organization to submit a proposal in their behalf. The award was then made to APSA for the work to be performed at Indiana University and Ohio University. In view of procedural changes, this practice may be questionable.

2. APSA, in providing oversight for the development of the CPE curriculum as the principal grantee, believes it represents the interest of NSF, the Association and the user community. It is not clear how a single group is able to balance the interests of such diverse parties.

3. The rationale for selection of reviewers is not apparent nor documented, but the selection does seem to include representatives from sectors representing political scientists, educators, and school administrators.

4. The level and the nature of monitoring conforms to NSF practices and it appears to be more definitive than that practiced in other similar agencies, but there is still a question of overall adequacy.

MAN: A COURSE OF STUDY (MACOS)

Man: A Course of Study (MACOS); *Education Development Center, Inc..; (EDC) formerly Educational Services, Inc: (ESI); Washington School of Psychiatry; Antioch College; others*

$4,797,380	(Development) EDC
326,000	(Evaluation Washington School of Psychiatry, Antioch College
44,700	(History) EDC
2,166,500	(Implementation) EDC, others
$7,334,580	

1963-1975; Grades 5-6

Development of the MACOS curriculum material was completed in 1970; projects on implementation and evaluation are continuing.

Information on NSF support of the curriculum development, implementation, and evaluation is summarized in tables 1-3.

In August 1963, the National Science Board was informed that the costs of developing the social science film project were estimated to be about $2.5 million over a five-year period. By January 1965, the total requirements for a social science curriculum project were estimated to be about $4.5 million over a 20-month period, an estimate noted at the January 1965 NSB meeting. Development was completed by 1970 at a total cost of about $4.8 million over a seven-year period.

The initial work, limited to social science films, was expanded to include social science curriculum development. Early estimates of costs and time required were lower than actual requirements. The materials produced were designed primarily for grade 5; development of curricula for high school levels was not completed.

Project Description

As described to the National Science Board in an August 8, 1963 memorandum, "This project is part of a comprehensive plan for developing a carefully integrated sequential social science-humanities program for elementary and secondary schools".[1]

A primary emphasis was on producing ethnographic film studies to deal with the questions: What is human about human beings? How did we get that way? How can we be made more so? The curriculum was designed to introduce organizing ideas early and restate them frequently by the use of films of people in other, and apparently quite different cultures. Students were to be encouraged to learn to use anthropological and enthnographic methods and materials.

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[1] The secondary schools curriculum development effort was later dropped.

Table 1.—NSF Grant Funds Awarded for Development of MACOS Curriculum and Evaluation, Fiscal Years 1963-75

Purpose and Fiscal Year	Requested	Awarded
Development		
1963	195,000	195,420
1964	618,315	513,360
1965	4,848,206	300,000
1966	—	1,200,000
1967	2,400,000	1,738,000
1968	1,460,334	430,000
1969	566,640	270,000
1970	527,005	150,000
Total	10,810,500	4,797,380[1]
Evaluation		
1970	14,377	14,000[2]
1972	463,581	49,400[3]
1974	595,160	262,600[4]
Total	1,073,118	326,000
History	57,359	44,700

[1] Educational Services, Inc. Education Development Center, Inc.
[2] Washington School of Psychiatry, Washington, D.C.
[3] Antioch College, Yellow Springs, Ohio.

Table 2.—NSF Grant Funds Requested and Awarded for Implementation of MACOS Development, Fiscal Years 1967-75

Fiscal Year	ESI or EDC[1]		Other Organizations	
	Requested	Awarded	Requested	Awarded
1967	35,538	35,500	—	—
1968	—	—	—	—
1969	13,250	11,000	626,000	445,000
1970	—	—	752,000	445,000
1971	—	—	471,000	387,000
1972	—	—	335,000	196,000
1973	—	—	NA	152,000
1974	331,000	25,000	NA	260,000
1975	15,000	10,000	245,000	200,000
Total	394,788	81,500	2,429,000	2,085,000

[1] Educational Services Incorporated; Education Development Center, Inc.
NA - Not available.
Between FY 1967 and 1975, requests from EDC for $331,000 and from other organizations for $1,241,613 were declined.
Source: Material supplied by Office of Assistant Director Education, NSF 4/25/75.

Table 3.—NSF Awards Directly Related to the Development of MACOS Curriculum

Grant number	Title, institution, principal investigator, amount, and duration	Award Date
GE 1831	"Films on the Archeology and Ethnography of the Tehuacan Valley, Mexico." Educational Services, Inc. Michael Coe (Yale University). $91,440. February 18, 1968 - December 31, 1963	3/26/63
GE 2567	"Films on Eskimo Culture". Educational Services, Inc. Douglas Oliver (Harvard University). $103,980. June 24, 1963 - August 31, 1974	1/29/63
GE 3430	"A Social Science Film Program." Educational Services, Inc. Douglas Oliver (Harvard University). $513,360 ending December 31, 1964	11/5/63
GE 3430-A1	"Social Science Curriculum Project". Educational Services, Inc. Elting Morison (MIT), J.S. Bruner (Harvard University), Franklin K. Patterson (Tufts University). $300,000, through September 30, 1966	3/19/65
GE 3430-A2	$600,000 through September 30, 1966	10/1/65
GE 3430-A3	$600,000 through September 30, 1966	6/13/66
GE 3430-A4	$105,000 through September 30, 1966	1/26/67
GE 3430-A5	$800,000 through September 30, 1968 Lawrence H. Fuchs (Brandeis University).	3/2/67
GE 3430-A6	$833,000 through September 30, 1968	1/10/68
GE 3430-A7	$430,000 through October 30, 1969 Lawrence H. Fuchs (EDC).	11/26/68

As reported in a 1972 brochure of Curriculum Development Associates, the publisher, *Man: A Course of Study*, the materials shown on the following list have been produced.

Films

"The Life Cycle of the Salmon" (10 min.)
"Herring Gull Behavior" (10 min.)
"Animals in Amboseli" (20 min.)
"The Younger Infant" (10 min.)
"The Older Infant" (8 min.)
"The Baboon Troop" (22 min.)
"Miss Goodall and the Wild Chimpanzees" (29 min.)
"Fishing at the Stone Weir" (30 min.)
"Life on the Tundra" (14 min.)
"At the Caribou Crossing-Place" (29 min.)
"Autum River Camp," Part I (26 min.)
"Autum River Camp," Part II (32 min.)
"Winter Sea-Ice Camp," Part I (32 min.)
"Winter Sea-Ice Camp," Part III (30 min.)
"The Legend of the Raven" (20 min.)
"Knud" (31 min.) (Optional)

Booklets

Life Cycle
Animal Adaptation
Information and Behavior
Innate and Learned Behavior
Natural Selection
Structure and Function
Salmon
Herring Gulls
The Observer's Handbook
Animals of the African Savanna
Baboons
The Baboon Troop
Baboon Communication
The Field Notes of Irven DeVore
A Journey to the Arctic
Songs and Stories of the Netsilik Eskimos
Antler and Fang
The Arctic
On Firm Ice
The Many Lives of Kiviok
This World We Know
The True Play
The Data Book
7 Additional Animal Books

Other Materials

Words Rise Up (2-12" records)
In the Field (2-7" records)
5 filmstrips
23 maps, posters and photomurals
3 educational games
Eskimo cards

Teacher's Guide

9 books containing background information, bibliographies, suggested lesson plans, strategies for evaluation and a series of in-service seminars for teachers.

History of Project Development

Needs Assessment.

During June 9-23 1962, prior to any NSF support, Educational Services, Inc. sponsored an Endicott House Conference in Dedham, Mass. ". . .to develop an overall unifying approach that would provide guidelines for structuring of a humanities and social studies curriculum running through the entire elementary and secondary sequence.[2]"

The conference grew out of conversations among Frederick Burkhardt, President, The American Council of Learned Societies, and Jerrold Zacharias, and Stephen White, of Educational Services, Inc. (ESI). The conference was supported by grants to ESI from the Ford Foundation, the Alfred P. Sloan Foundation, The American Council of Learned Societies, The New World Foundation, and the Kettering Foundation.

Participants in the Endicott House Conference included some 61 persons representing social science disciplines plus those of law, history, physics, and education.

A report on the conference, *A Narrative Report 1962-1964 Social Studies Curriculum Program:*, November 1964 concluded that, ". . .the teaching of the general field of social studies and the humanities was desperately in need of improvement in the elementary and secondary schools of this country". The report also notes that the participants did not realize the time, effort, and money that would be required to remedy this situation.

Proposals from Educational Services, Inc.[3], and the American Council of Learned Societies received by the Foundation on January 3, 1963, described a review of 250 existing social science films conducted in August-September 1962 by ESI and ACLS staff headed by Douglas Oliver (Harvard, Anthropology).

This review of films resulted in a number of criticisms:

- Minimal involvement of social scientists leading to inaccurate and misleading generalizations and dubious techniques of documentation
- Emphasis on dramatic effects at the sacrifice of presenting honest data in clear and unequivocal style
- Failure to provide for questions or explorations by students
- Misrepresentation of the spirit of scientific inquiry in the social sciences
- Failure to present information so that students could work with it
- Lack of imagination in the use of film as a medium.

The proposal was to deal with these shortcomings by having films made by social scientists and reviewed by experts; by producing films that could be used for children at all grade levels and could be edited for viewing by a general audience; by providing a flexible format; limiting the films to data that could be best represented by film, leaving much to the student to be interpreted; and by experimenting with film innovations.

In addition, two conferences on the problems of social science were supported by the Office of Education and the Foundation and sponsored by the President's Scientific Advisory Committee. Discussions of issues by the NSF Advisory Committee on Course Content Improvement Programs and by the Division's Committee for Scientific Personnel and Education led to the conclusion that there was an urgent need for course improvement in the social sciences. Recommendations were made that the Foundation support social science curriculum development projects.

Analysis of Impact.

The MACOS materials are estimated to be in use in about 1,700 schools in 47 states. Estimates of students affected range from about 200,000 to 328,000. The materials are also being used in five Canadian provinces and in England, Scotland, North Ireland, and New Zealand. One report[4] estimates that in 1970 the MACOS materials were being used by about 200,000 children and that the number of schools using the materials had increased from about 375 in 1967 to about 1,700 in 1970.

A review of the MACOS project files yielded no systematic information on the extent of actual use of the materials in schools. Materials on community response are mainly newspaper accounts, reports of very small-scale mail surveys, or anecdotal information. These materials do indicate that MACOS was a subject of controversy as early as 1971 and that certain NSF projects dealing with the social sciences were a matter of cautionary Congressional comment in August 1964.

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[2] The quotation and other material on needs assessment are from proposal E3/4 3750 from Educational Services, Inc. and the American Council of Learned Societies and received by the Foundation on January 3, 1963.

[3] The corporate name was later changed to Education Development Center, Inc. (EDC)

[4] *Promoting Change in Schools*. Far West Laboratory for Educational Research and Development. San Francisco. 1974. p. 127. (The estimate in the report that the ". . .200,000 users. . . represent 18 percent of the market" is in error. The percentage should be 1.8.

Thus, from the materials available in this review, there is no sound basis for making valid estimates of the extent of the use of MACOS materials over time or of the impact of the MACOS curriculum on the places where it was used.

Review History.

Does the proposed subject matter fit within reasonable limits or norms with respect to educational value?

Estimates of the need for the development of curriculum that led to the development of MACOS materials were based on a major conference of experts in social science and in education after review of existing social science films of about a decade ago; on two conferences sponsored by the then President's Scientific Advisory Committee; and after encouragement from advisory groups to the NSF Education Directorate. Prior to support of MACOS related projects, NSF had supported the development of secondary curricula in anthropology. Each major MACOS related award was subject to peer review and/or staff review and submitted, as revised on the basis of those reviews, to the National Science Board for approval. It appears, then, that in the judgment of scientific peer reviewers, representatives of the educational community, staff of the Education Directorate, and the National Science Board that the proposed subject matter did fit within reasonable limits or norms with respect to educational value.

Is the scientific content accurate?

Peer reviews of MACOS-related projects indicate that there was little question about the accuracy of the scientific content of materials that would be produced. It appears that this judgment of peer reviewers was based primarily on their estimate of the competence and experience of those who were to be conducting the projects.

Were course developers responsible and competent persons?

The judgments expressed by peer reviewers and by NSF staff were that those responsible for the course development were responsible and competent.

Were institutional and contractural arrangements sound?

In December 1966, ESI presented the 10th grade materials to 70 publishers. A general meeting to which 58 publishers were invited to consider possible publication of MACOS fifth grade material was held on June 16, 1967. Subsequently, 43 potential publishers were personally contacted by a senior official of the organization under its new corporate name, Education Development Center Inc. (EDC). The publishers contacted evidenced varying degrees of interest but for the most part, declined the opportunity because of an EDC requirement for teacher training before use of the material as an integral part of any publishing agreement. In addition, publishers were hesitant because of the limited potential for profit and because the plan involved multi-media educational materials.

Amendment no. 8 to grant GE 3430 was awarded June 29, 1963 to EDC for initial publication in the anticipation an acceptable commercial publisher would be secured. A revolving fund of $270,000 was established for this purpose. It provided for the distribution of 1,000 sets of materials consisting of films, teachers' guides, games, etc. The income received by EDC was sufficient to offset all costs against the grant which was subsequently cancelled by NSF.

EDC continued its search for a publisher of the educational materials and in 1970 carried on serious negotiations with four potential publishers: Initial Teaching Alphabet (ITA), Instructional Services Incorporated (ISI), Westinghouse Learning Corporation, and Curriculum Development Associates (CDA). Each of the four publishers was fully informed by EDC of the conditions of the contract. On March 5, 1970, officials of EDC requested NSF approval of its intent to select CDA as the contractor for publishing the educational material of MACOS. NSF approved the selection of CDA in a letter dated March 13, 1970.

On May 22, 1970, EDC submitted to NSF a draft publishing agreement between EDC and CDA.

The transmitting letter stated:

> "CDA recognizes that a unique dissemination plan must be developed in order to introduce the course. CDA therefore has requested EDC to assist in certain continuing activities:
>
> 1) Maintaining liaison with schools and school systems, college and university pre-service training programs and with appropriate private and governmental agencies concerned with curriculum and staff development.
>
> 2) Identification of present or prospective users of the work and leadership teachers trained in summer institutes.
>
> 3) Assistance in the development of teacher-training programs (both in-service and pre-service).
>
> 4) Joint development of a communications and information exchange among education institutions using the work.
>
> 5) Revision, modification or supplementation of the work.
>
> 6) Continuing research and evaluation of the extent to which the work is accomplishing its objectives.
>
> CDA and EDC will thus be partners in the dissemination and promotion efforts and CDA proposes to contract separately for EDC's services. This will be done by negotiating quarterly payments to EDC based upon one half of CDA's dissemination and promotion budget which in no case will be less than the normal commercial dissemination/promotion budget for multi-media materials of this type."

Included in the draft publishing contract on page 4, item 4 (a) was the provision that CDA was: (1) To provide or arrange for, in cooperation with and in a manner satisfactory to EDC, teacher-training programs for prospective users prior to their adoption of the work and in-service teacher workshops subsequent to adoption of the work; (b) explore new methods of teacher-training in an effort to expand the use of the work in pre-service as well as in-service programs."

This draft agreement was reviewed by the staff of the Education Directorate, Office of the General Counsel and the Grants Office. There is no evidence in the files to indicate whether or not the transmittal letter from EDC accompanied the draft contract when it was reviewed by the appropriate NSF offices. The Assistant Director for Education at that time gave NSF approval of the draft contract on July 7, 1970. The draft contract as approved was signed by representatives of EDC and CDA on July 20, 1970. During the course of the review of the MACOS project a copy of a second agreement was obtained on April 15, 1975, from the files of EDC. This subcontract provided the detailed working arrangements for Section 4(a) and (b) in the contract approved by NSF on July 7, 1970. The service contract provided for staff services to be furnished by EDC for which CDA would pay EDC "one-half of its promotion-dissemination budget which in all instances will be equal to or greater than that which prevails in normal commercial practice for the dissemination of multi-media educational materials."

In the course of this review, the program contract file was checked by the team to determine if NSF review and approval of the second agreement was documented. There was no documentation of this item nor was there a copy in NSF files. It appears that this subcontract did not require Foundation approval under the policy in existence at that time and would not have been required under existing practices. The Foundation had actually approved the arrangement, of which details were spelled out in the service contract, by signing the draft publishing contract on July 7, 1970.

The basic grant GE 3430 and each of its amendments contained in fact or by reference a standard NSF royalty income clause to the effect that separate accounts were to be maintained and use of income authorized by NSF.

Because of the nature of the MACOS project and the teacher training requirements which EDC required being written into the contract, the task of locating a suitable publisher was difficult. The contractual arrangements between EDC and CDA which finally evolved, though somewhat at variance from the norm, appear to be fiscally sound and adequate for the purposes intended.

The proposals that led to the development of the MACOS curriculum submitted to NSF on January 3, 1963 by Educational Services, Inc. and by the American Council on Learned Societies requested $284,200 for the preparation of anthropological films. Sections A through E of each of the four proposals were identical and the proposals so stated. They differed in the content of Section F which proposed film production in four distinct cultures.

All four proposals were submitted to peer review. Awards were made for two projects (tables 1-3) the other two proposals were withdrawn in August 1963. The awards did not involve either policy issues or levels of funds requiring NSB approval.

On the advice of NSF staff, the same grantee organizations submitted a consolidated proposal requesting $618,315 for additional work on the two projects that had been supported and for incorporating work described in the two proposals that had been withdrawn. This consolidated proposal was not submitted for additional peer review; NSF staff recommendations for support were based on results of peer evaluations of the earlier separate proposals that had been reviewed. The staff recommendation for support, at a reduced budget level, was submitted to and approved by NSB.

All subsequent proposals for continued substantive work (Amendments GE 3430 A1, A5, and A7), received peer review and review by NSF program staff. In each instance, the program staff summarized the major issues raised by reviewers and made recommendations for support to senior staff of the Directorate. In each instance, the recommendation was a reduced work plan at a lower level of effort than had been proposed and was submitted to and approved by the National Science Board. Information on reviews of the proposals is contained in Table 4. Final recommendations reflected the adverse criticisms of reviewers and staff analysis of the needs and status of the project.

Monitoring History

Monitoring of the MACOS projects appears to have taken the form of peer review and staff review of the proposals submitted for specific work elements. These reviews resulted in modifications in the budgets requested and occasionally resulted in modifications in the scope of work. Only two site visits are recorded during the course of the MACOS curriculum development. Major responsibility for the conduct of the work was with the principal investigators and the planning committee of social scientists and educators assembled by the grantee.

Dissemination/Implementation Plan

Major difficulties were encountered by EDC in developing and carrying out dissemination and implementation of MACOS curriculum. When the course came on-line, as indicated earlier, EDC encountered strong negative reactions from potential publishers about marketing MACOS. The publishers believed the program had four

Table 4.—Summary of Review of MACOS-Related Proposals

Reviewer Characteristics and Recommendations	GE 1831 GE 2567	GE 3430[1]	Amendemnts[2] #1	#5	#7
Affiliation					
College and University	4		8	5	6
State Education Agencies	—		1	—	—
Elementary or Secondary Schools	—		1	1	—
Other nonprofit	2		2	2	2
Federal agency, non-AD/E	1		—	—	—
Discipline					
Anthropology	7		6	2	2
Education	—		5	2	3
Sociology or Social Psychology	—		1	4	2
Economics	—		—	—	1
Recommendation					
Support as submitted	6		10	5	—
Support, with reservations	—		—	—	2
Do not support	1		2	3	4
Ambiguous	—		—	—	2
Total Number of Reviewers	7		19	8	8

[1] The proposal leading to award GE 3430 was not reviewed as such. Review was based on evaluation of four earlier proposals that included work to be done under GE 3430 and that resulted in support of GE 1831 and GE 2567.

[2] Two persons reviewed all three proposed amendments; one person reviewed two of the three proposed amendments.

major liabilities that made marketing it a risk of capital, time and personnel:

- Unconventional concepts
- The need for special teacher education
- The interrelatedness of media with function
- The cost of the program.

In 1969 and 1970 (prior to EDC obtaining the services of a publisher) NSF supported a small number of regional centers (six in 1969, five in 1970, four in 1971) through the Foundation's Course Content Improvement Program. The total cost of these centers ranged from $445,200 in 1969 to $154,900 in 1971. The centers were strategically located in universities and colleges in Florida, Oregon, Colorado, Connecticut, New York, and other states. The purpose of these centers was to furnish information concerning the MACOS curriculum in the school districts of the region. When the desire was expressed to use the MACOS curriculum, appropriate teacher training was provided by the centers. These centers were discontinued shortly after Curriculum Development Associates (CDA) contracted to publish and disseminate MACOS curriculum.

Because of the innovative nature and unconventional concepts of the course, EDC felt strongly that teachers should receive specific training prior to teaching MACOS in the schools and had made this a requirement for publishing the course. When CDA contracted with EDC as publisher of MACOS, it did so with the understanding that EDC's purpose and desire would be carried out "to maximize, proceeding now as rapidly as possible, the dissemination of *Man: A Course of Study*." and "to achieve this maximum dissemination, at the same time, on a basis that is consistent with the teaching and learning principles that characterize the *Course* and that will assure so far as possible the continuing opportunity to develop those principles further." In addition CDA officials stated that they would "be insistent on a method and program of dissemination which provides the teachers who use the *Course* with full exposure to the use potentials conceived of by those who have developed it;" and would "seek a financial arrangement which provides maximum opportunity for further development by the *Center* of this and other teaching-learning courses."

CDA was given full responsibility by EDC to develop the production and dissemination program. CDA proceeded to establish targets for the dissemination of class sets immediately upon signing the publishing contract in 1970. At that time, the goal was on the order of 450,000 students using the course in the 1972-73 school year.

In carrying out EDC's desire to make teacher training an integral part of the package, the CDA Price Information Sheet for materials developed for MACOS contains the statement, "All orders for classroom or film materials are subject to verification by CDA that the purchaser has compiled with teacher education requirements necessary for proper implementation of the *Course*."

NSF provided support for teacher training for MACOS through its Summer Institutes Program, its Course Content Improvement Program and its Cooperative College School Program. Beginning in FY 1974, NSF supported specific implementation proposals relating to MACOS, principally as part of larger, comprehensive projects. These implementation grants vary considerably in the type of training and the target community. For instance, support varies from awareness conferences to teacher-centered projects which have built-in evaluation components. As with most curriculum implementation efforts, a multiplier effect is considered highly desirable; trained personnel are expected to return to their school districts and train other teachers in the effective teaching of the MACOS course.

Misconceptions have arisen concerning the implementation awards for teacher training made by NSF because EDC, in its literature on the MACOS material, has referred to funding by the Foundation of university/college/school district regional centers. At the present time NSF does not fund any regional centers for dissemination/implementation, and has asked EDC to delete reference to NSF support of "regional centers" from its publications.

The following is an excerpt from the publication of the Far West Laboratory for Educational Research and Development previously cited.

MACOS

Synopsis of diffusion: The earliest diffusion efforts met with little success. Publishers were unwilling to take on a controversial multi-media program; workshops for teachers elicited enthusiasm about the course but resulted in pilot efforts, not adoptions.

When CDA took on MAN, its staff had no intention of applying conventional sales techniques to the diffusion of such a complex, controversial program. Instead, they have emphasized professional staff development in the training that is prerequisite to implementing the course. Teachers learn not just content and teaching methods, but also curriculum development, evaluation, and dissemination. They become colleagues of the developers and of the "International Faculty," the group of university professors, museum anthropologists, curriculum specialists, and others, who conduct the workshops and engage in their own dissemination efforts for MAN. The prestige of this group is thought to be an important element in the curriculum's recent diffusion success.

CDA concentrates much of its effort on key decisionmakers in schools. Evaluations of the early dissemination showed that it was school administrators with a role in staff development who were able to bring about use of MAN once they were convinced of its worth, and so CDA now holds 'awareness-toward-decisionmaking' workshops for these administrators (followed up by similar workshops for teachers). Another set of workshops is the 'three-day institutes' designed to equip teacher educators to respond to the training needs of purchasers of the course while also disseminating information about it. Workshops are also held in conjunction with the national conferences of various educational associations. The focus in all cases is on people who are in a position to take action for the program's implementation.

The publisher's dissemination activities are evaluated cooperatively by the publisher and the developer, EDC, and the resulting data shape subsequent activities. Several barriers to adoption have been identified in this way, and new tactics have been devised to overcome the barriers. For example, the materials' high cost was alleviated by means of a lease/purchase option that allows purchase with three annual payments. Problems of MAN's discontinuity with other curricula are being met by working with all the teachers in a school and looking at the total curriculum rather than grade-by-grade adoption.

Problems suggested by Detailed Review

Although the review of NSF procedures related to MACOS did not identify any major procedural problems, the review did raise some question concerning the effectiveness of current practices. Dealing with the problems noted below might require changes in NSF policies, or modifications of peer review and other procedures. Any significant changes would probably require additional staff resources and funds in order to provide intensified monitoring and review.

Needs Assessment

Options include imposing a requirement that each curriculum development proposal contain a statement assessing the need for the project, estimating the potential marginal contributions of the proposed work and estimating the total cost and time required to complete the project.

The Foundation might consider initiating its own curriculum needs assessment process after which projects to be assigned high priority could be identified.

Project Monitoring

A comparatively weak aspect in management of the MACOS project appears to have been its monitoring. Site visits by NSF staff were few, and no detailed review was made by NSF staff of contractual arrangements between the principal investigator and the publisher.

Under NSF's present approach to managing course content development projects, the grantee has virtually free rein in management and development of the curriculum including its content. The Foundation might wish to consider requiring closer staff monitoring of projects and more strenuous evaluation of the products derived from the projects.

Also suggested is a lack of top-level oversight by the grantee such as advisory committees or other mechanisms. Consideration might be given to *requiring* that an active oversight body be appointed by each grantee, consistent with existing legislation. Also, NSF might wish to consider current requirements for systems of record maintenance by the grantee on the results of evaluations of specific projects and of the contributions of principal investigators. Appropriate experts within the Foundation could then study the nature or uniqueness of such relationships and mechanisms, such as in the MACOS project, leading to the establishment of an NSF policy on such relationships and mechanisms.

Also suggested for NSF consideration would be development of procedures that must be taken on NSF approval of all subcontracts, by the grantee and NSF staff to include a record system on subcontractor negotiations and information on competitive negotiations between the grantee and subcontractors.

Peer Review Procedures

These procedures might be modified to provide guidelines tailored to specific proposals. Consideration might also be given to broadening the present peer review system to include representatives of other groups such as teachers, parents and community leaders.

Other

In some instances the grantee has published misleading information concerning Foundation support. NSF might consider requiring joint NSF-grantee review of all press releases or publicity about the work supported.

INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM (ISIS)

Individualized Science Instructional System (ISIS); *Florida State University, Tallahassee;* $3,353,105; 1972-1977 (funded) 1980 (proposed); Grades 10-12

The ISIS project is focused on developing a flexible, open-ended, interdisciplinary curriculum that will facilitate individualization of science instruction at the high school level.

The commercial version of the program will be published by Ginn & Co. as a set of approximately 80 minicourses (segments) which can be sold individually. Ginn retains exclusive rights to publish the ISIS materials until December 31, 1984, after which exclusive publication rights expire.

Trial Centers

The ISIS project has eight supported trial centers and fourteen independent trial centers which participate in the field tests of ISIS materials. These centers are located in the following cities:

Supported Trial Centers

Atlanta, Georgia
Tallahassee, Florida
Hauppauge, New York
Newtown Square, Pennsylvania
Evanston, Illinois
Dallas, Texas
San Diego, California
Concord, California

Independent Trail Centers

Farmington, Maine
Lexington, Massachusetts
Albany, New York
Upper Marlboro, Maryland
Dade City, Florida
Detroit, Michigan
Hilbert, Wisconsin
Memphis, Tennessee
Conway, Arkansas
Stillwater, Oklahoma
Manhattan, Kansas
Minneapolis, Minnesota
Sacramento, California
San Jose, California

The supported centers receive ISIS materials at no cost, while the independent centers pay only the cost for production of the materials they use. Neither Ginn & Co. nor Florida State University realizes a profit on these materials.

Current Status

Twenty-four ISIS minicourses were field tested throughout the country during the 1974-75 school year, and some will be added for 1975-76. Most of the more than 200 teachers using ISIS trial materials have selected about 12 of these minicourses for use in their classrooms. However, several ISIS trial teachers are involved in exploring different ways of managing a year-long science instructional program comprising all of the minicourses.

Over 7,000 students and nearly 90 teachers in 48 high schools across the country are participating in the evaluation of ISIS materials in the supported trial centers. In the independent centers more than 3,500 students and more than 120 teachers in 60 high schools are using ISIS trail materials and are testing the ISIS minicourses in real-world classroom settings. Although they are not involved in a systematic evaluation of each minicourse, the independent centers are providing valuable feedback to the ISIS staff because they give a sneak preview of what can happen when ISIS materials are used by students and teachers in schools that are less tightly linked to the ISIS project.

Funding History

Grant	Award Date	Expiration Date	Award Amount
GW-7645*..	9/29/72	6/30/74	$290,000
Amendments:			
1	3/5/73	6/30/74	55,000
2	6/8/73	6/30/74	60,000
3	8/17/73	6/30/74	772,700
4 (No cost extension of expiration date to 9/30/74)			905
5	6/28/74	9/30/76	1,694,905
6	12/5/74	3/31/77	480,500
Total ..			$3,353,105

* New PES 72-06306

Description and Objectives of the Project

ISIS will consist of approximately 80 short, essentially independent modules or minicourses, each requiring 2-3 weeks of classroom time. Each module will deal with a specific topic by presenting, in an interdisciplinary manner, the appropriate concepts from biology, chemistry, and physics. Pertinent information from the social sciences is incorporated in units that deal with the social implications of science and technology. Mathematics is included when necessary. For each module, "excursions" are developed which permit the student to probe into some of the more complex aspects of the topic. In an effort to keep down the equipment costs for schools adopting ISIS, the laboratory work makes use of materials and apparatus normally available in high school science labs. Guidance in implementing ISIS under a variety of situations is provided by an instructional management scheme.

Short- and long-range goals of the project are:

- Elimination of the unnatural barriers between scientific disciplines in an effort to provide the student with a better understanding of science.
- Development of materials which will (a) motivate students and provide them with sufficient knowledge to be scientifically literate and (b) permit more capable students to select and attain more advanced instructional goals.
- Formulation of a model which, hopefully, will promote changes in other subject-matter disciplines and, eventually, in the structure of the secondary school system.

Narrative History of Project Development

Under a grant dated June 23, 1971, NSF provided support for a conference held at Callaway Gardens, Georgia in October 1971 which brought together 34 experts to explore the feasibility of a new approach to high school science. This conference was proposed by Dr. Ernest Burkman of Florida State University and was supported under NSF Grant GW-6799 at a level of $10,600.

The persons attending the conference represented a broad range of experience in science and school instructional materials development. There were one or more university chemists, physicists, biologists, physicians, and economists. There were several people who had played roles in the development of PSSC physics, the CHEM Study, BSCS biology, ECCP engineering, ISCS junior high science and AAAS and QS elementary school science. Every branch of the teaching profession was represented including classroom teachers, science supervisors, school administrators, professors of science education and learning theorists. There was also representation from various professional organizations such as National Science Teachers Association, Social Science Education Consortium, Council on Physics Education, the American Institute for the Biological Sciences, and the AAAS Commission on Science Education.

The conference participants cited what they felt was considerable evidence for the inability of the then current science programs to meet the needs of today's society, today's schools, and today's students. They felt that:

- Many high school students were complaining vigorously about irrelevant content, authoritarian teaching methods, and overly centralized decisionmaking.

- Many parents and government officials were alarmed over the high cost of the educational system.
- Many young people were becoming more and more negative in their attitudes toward science which seriously suggested that science teaching was failing to communicate with students.
- Most current curricula at that time tended to emphasize pure science at the expense of applied science and that this emphasis on the development of abstract concepts had proven too difficult for many students and had become increasingly difficult to defend.

The conference participants concluded that the progress of the past decade had prepared the way to take a new step and that a new step was indeed needed. They recommended the development of alternative curriculum materials that

- Focus upon individualized instruction.
- Strike a happy balance between theoretical and applied science.
- Place a considerable emphasis upon social implications.

In January 1972 the final report of the Callaway Gardens Conference was sent to NSF. In March 1972, a proposal from Florida State University was submitted to NSF requesting support of an effort to implement the conference recommendations. The proposed project titled the "Individualized Science Instructional System Project" (ISIS), was initially funded by NSF in September 1972.

In a number of ways the ISIS effort is an outgrowth of the NSF supported Intermediate Science Curriculum Study (ISCS), an individualized coordinated science sequence for grades 7-9. NSF project support for ISCS curriculum development activities at Florida State University terminated in 1973. The project director for ISIS, Dr. Ernest Burkman, was also the original project director for ISCS, and several former ISCS staff members are now members of the ISIS staff. ISIS may be viewed as an effort to provide both a second generation model for individualization and an appropriate set of instructional materials for junior high school students who have been exposed to ISCS as well as those who have not.

Description of the Minicourses

According to the project director, the ISIS minicourses will not simply be a set of plans, but rather will be complete learning packages containing everything the teacher needs to provide students with individualized science instruction. Each ISIS minicourse will have the following components:

1. A description of what the student is expected to know or be able to do in order to start the minicourse
2. A student-language description of what the minicourse is designed to teach
3. Fairly flexible suggestions on how the student can use the minicourse materials to achieve these goals
4. Instructions for carrying out each learning activity
5. All necessary text materials, most likely in pamphlet form
6. Any loops, slides or other audiovisual materials required
7. Highly specific self-tests so the student can determine when he has achieved the desired learning objectives
8. Suggested answers to the self-tests and suggestions as to how the student can correct his/her deficiencies
9. Any necessary equipment that cannot be assumed to be in the classroom
10. Materials to help the teacher implement the minicourse

The ISIS developers feel that such a complete package will free the teacher from much of the routine of a classroom, and allow the necessary time for interaction with individuals or small groups.

To indicate the scope of topics, brief descriptions of planned minicourses, most currently in trial, are given below:

Buying and Selling: The psychology of selling, subliminal advertising, packaging, nonverbal signals, association psychology.

People Pressure (not yet in trial): Population explosion, cyclic and non-cyclic resources, birth control, sociological and psychological effects of crowded living.

Seeing Colors: How we see color, color subtraction in mixing paints and filters, color addition in printing and color TV, color fatigue, day and night vision, colors of signs and emergency vehicles.

Ways We Learn: Some experiments in the learning of humans and other animals, factors which favor learning and forgetting.

Heart Attack: The circulatory system, its normal functioning and malfunctioning.

Plants Indoors: Growing healthy plants under unfavorable conditions, leading to the requirements and mechanisms of plant nutrition and growth.

Fire and Explosion: Explosions involving rapid oxidation, relationship of concentration of reactants and particle size, dangerous household situations.

Home Electrical Appliances: Fault diagnosis and repair, what is safe to do and what is not, circuits of simple household appliances, effects and treatment of electrical shock.

Household Energy: The options available at the community and individual level in the selection of sources of power, the analysis of cost, and the feasibility and convenience of each.

Two other proposed minicourses are described in a more expanded form to illustrate the variety of approach possible in a minicourse structure and possible relationships between core and excursion activities.

Sounds of Music: The starting point of this minicourse is a cassette tape of a practice session by a high school dance combo. Members of the group discuss on the tape the characteristics of the notes of their various instruments. Students follow this discussion through a printed booklet in which the wave forms of notes which differ in pitch loudness or harmonics are shown. This introduction leads to laboratory exercises using musical instruments in which the ideas introduced in the tape are developed and consolidated. The excursions enable students to consider a range of related topics such as the physiology of musical perception or the quantitative relationships between pitch, tension and length of stretched strings.

Packaging Passengers: This topic is focused on the packaging of humans to lessen injury in auto crashes. The students use experiments, filmed sequences of simulated crashes and data to develop the relationship between injury and deceleration time and to study the effectiveness of seat belts, air bags and other design features in reducing injury. The excursions enable students to pursue the topic further by undertaking a consumer survey of seat belts, debating whether the wearing of seat belts should be compulsory, packaging an egg to withstand dropping, considering the natural packaging of the eye, fetus and brain, or calculating pressure of impact and other quantitative aspects of collisions.

Analysis of Impact

ISIS trial materials are currently being used by more than 10,000 high school students attending the ISIS trial center schools located throughout the U.S. It is still too early to assess the actual impact of the ISIS program since no final versions of minicourses have been developed.

According to the ISIS developers there is already a high demand for ISIS materials, and they plan to release minicourses as soon as they are completed.

Twenty-nine trial minicourses have been made available for the 1975-76 school year, and plans are to release an additional twenty minicourses during each of the following three years.

Two of the trial minicourses produced by ISIS are considered sex education by some—*Reproduction* and *Birth and Growth*. Recognizing this fact, the ISIS staff sent letters to all principals whose schools were using ISIS materials informing them of the possible sensitive nature of these two minicourses. One trial center (Dallas, Texas) decided not to use the two minicourses.

Review and Oversight History

Both the Callaway Gardens conference proposal and the subsequent ISIS proposals were unsolicited and were submitted to the NSF Pre-College Education in Science (PES) program. Program announcements concerning PES activities are widely disseminated, and state that they are designed to generate a variety of proposals for innovations in pre-college science education.

Criteria established for ISIS reviewers required that they 1) represent a cross-section of disciplines; 2) be prominent in their areas of speciality; and 3) be interested in and experienced with pre-college education. It appears that all ISIS proposal reviewers met these criteria.

Reviewers were directed to make an evaluation of the proposal based on the merit of the idea, the feasibility and effectiveness of the procedure, the qualifications of the persons who would carry out the project, and the reasonableness of the budget.

During the initial development of ISIS, two committees appointed by project staff provided oversight to the project's activities, the Planning Committee and the Advisory Committee. The Planning Committee's task involved the actual production of guidelines and samples of topics, whereas the Advisory Committee's function was to review such materials and give advice on general policy.

Early on, however, it became apparent that the two committees did not provide the desired flexibility for carrying out the ISIS project activities. A single less-structured Advisory Board was formed to replace the two committees. Many who were on the original committees were placed on the new Board, but there were a few additions and deletions to obtain the disciplinary balance needed. A number of teachers and science supervisors were added, for example, to get an input from those closest to the classroom situation.

ISIS has divided the members of the Advisory Board into short-term task forces containing the combination of talents required to deal with particular problems that arise. Thus, there are few meetings of the entire Board. Instead, relatively small groups of advisors, clustered on the basis of their competencies concentrate, as needed, on problems in their area of expertise. Some groupings are multidisciplinary, while others are more discipline centered.

The members of the ISIS Advisory Board are:

ISIS ADVISORY BOARD

John Bare
Psychologist
Carleton College, Minnesota

William Bass
Anthropologist
Univ. of Tennessee

Gregory Choppin
Chairman, Dept. of Chemistry
Florida State University

William Cook
Dean, College of Natural Sciences
Colorado State University

John Davis
Superintendent of Schools
Minneapolis Public Schools

Earnestine Forte
Biology Teacher
Miami, Florida Senior High School

Robert Gagne
Psychologist and Professor of Instructional Design and Development
Florida State University

Darrell Goar
Science Coordinator
Moline, Illinois Secondary Schools

Franz Halberg
Professor of Health Sciences
Chronobiology Labs, Medical School, Minneapolis

Wayne Holtzman
Educational Psychologist
University of Texas

Allene Johnson
Chemistry Teacher
Summit N.J. Senior High School

Leon Jordan
Biology Teacher
Trevor G. Brown High School
Phoenix, Arizona

Edward Kormondy
Biologist, Vice President, and Provost
Division of Natural Sciences
Evergreen State College, Washington

Alfred Kuhn
Economist
University of Cincinnati

Robert Lehrman
Chairman, Science Department
Roslyn High School
Roslyn Heights, N.Y.

Dorothy Magett
Director of Human Resources
Evanston, Ill. Township School

W. T. Martin
Mathematician and Director
Division for Study and Research in Education
Mass. Institute of Technology

Howard Mehlinger
Political Scientist and Director of
Social Studies Development Center
Indiana University

Irving Morrisett
Executive Director
Social Science Education Consortium
Boulder, Colorado

Rod O'Connor
Chemist
Texas A&M University

Benjamin Peery, Jr.
Astronomer
Indiana University

Reubin Pierce
Principal
Ballou Senior High School
Washington, D.C.

Samuel Postlethwait
Biologist
Purdue University

Douglas Reynolds
NY State Science Supervisor
Albany, N.Y.

Charles Russell
Assistant Principal
Northern High School
Detroit, Michigan

Milton Saslaw
Director, Dade County
Florida Department of Public Health

Raymond Staley
Oceanographer
Florida State University

Dallas Stewart
Georgia State Science Supervisor
Atlanta, Georgia

William Story
Texas State Science Supervisor
Austin, Texas

Donald Thomsen, Jr.
President
SIAM Institute for Mathematics
and Society
New Caanan, CT

John Truxal
Dean
College of Engineering
State Univ. of New York at Stony Brook

Elizabeth Wood
Physicist
Bell Laboratories (retired)

Chen Ning Yang
Physicist
The Institute for Theoretical Physics
State University of New York at Stony Brook

Herbert Zim
Science consultant, editor, and writer
Tavernier, Fla.

Source: ISIS Newsletter No. 3, Florida State University, Tallahassee, Fla., Dec. 1974.

Proposal Review

All reviewers agreed that the development of the project was opportune, especially in view of the proposed flexibility of the curriculum and its modular structure, and all recommended funding but none without raising questions, as is usual in the review process, on aspects of the proposal plan.

Reservations focused on five main areas of concern: (1) Some reviewers felt that scientific concepts very often build on each other and were apprehensive that the nature of the proposed curriculum would prohibit such growth. (2) There were questions regarding the management system for schools and teachers which the proposal promised to provide. It was felt that the system was neither sufficiently explained nor was the management plan begun early enough in the curriculum development stage. (3) Some reviewers felt that there was inadequate provision for laboratory and problem-solving situations within the learning scheme. (4) The evaluation procedures were attacked for being insufficient and too informal. (5) There was some speculation that the method of development might prove inefficient.

Sections of reviewers' comments were sent to Dr. Burkman at Florida State for his comment prior to a final decision on the disposition of the proposal. Dr. Burkman replied in detail to the critical points that were raised. In addition, PES staff met with ISIS project staff to clarify matters further. These elements of the decision process are documented in an internal program memorandum of Sept. 5, 1972.

The PES staff indicated that they were satisfied with the project staff's reactions to reviewers' concerns and strongly recommended an award of $550,000 for start-up and initial development of the project. The PES staff also recommended that this award be followed by an award for the balance of the budgeted $1,127,700 at an appropriate date if the initial phase proved satisfactory.

In the written material presented to the National Science Board, reviewers' remarks concerning the original proposal could appear to be taken out of context and appear to be a misrepresentation of what the reviewers actually said. This is because the NSB writeup does not describe the negative comments, Dr. Burkman's detailed rebuttal, and the meeting between ISIS and NSF staff which dealt adequately, in the staff's view, with reviewer criticisms. A list of specific accomplishments of the project to date was included in the staff recommendations to the National Science Board. They included:

a. Development of a specific statement of goals desirable for a high school science program.

b. Formulation of an overall matrix of minicourse topics.

c. Selection of a publisher.

d. Field evaluation of ten minicourses having titles such as: Household Chemistry, Heart Attack, Packaging Passengers, and Buying and Selling.

e. Development of a preliminary framework for the instructional management scheme.

The second ISIS proposal for support of the project during the period July 1974—September 1976, received an in-house staff review. Continuation of the initial effort at a level of $2,175,400 was approved by NSF staff and the National Science Board. NSF staff felt that it was not necessary to have the proposal reviewed on the outside, since the initial proposal had included plans for the continuation and had been evaluated on this basis.

Evaluation of Materials and Processes

In this curriculum development project it is important to differentiate between formative and summative curriculum evaluation. Formative evaluation involves the collection of information which can be used to improve instructional materials in terms of their impact upon children. Summative evaluation seeks to determine what happens to children as a result of exposure to a fully developed product. A discussion of the summative evaluation of the proposed product was not made in the original proposal because the principal investigator felt that such an effort could not be carried out for at least seven years.

The proposal recommends criterion-referenced testing rather than normative testing. The object is to find out how many children meet specific criteria rather than how many achieve an average score on a test. Because criterion-referenced testing is done item by item rather than by test, existing normative-based standardized tests are not considered appropriate for the purposes of the ISIS project.

The evaluation plan is described as follows:

1. Goals for secondary science teaching will be established and the selection of module topics will be on the basis of these goals.
2. Each module will include a specific description of what the student is expected to know or be able to do after completion of the module.
3. When each module is field tested, a goal will be to ascertain how many students perform as expected after completing the module. Revisions will be aimed at increasing the number.
4. The project staff expects to be unable to establish objective means to measure the desirable outcomes of some modules. In

these cases they will use the subjective judgment of teachers, of students, and of the staff to determine whether the objective is being accomplished.

5. In addition to evaluating student success in meeting the criteria of each module, the project staff will ask teacher and student opinion on how a given module might be improved. Through this kind of subjective information, the staff hopes to detect evidence of such correctable problems as poor communication, unrealistic time estimates and invalid judgments about the level of knowledge and skill possessed by most students.

Additional information to clarify how the above steps will be accomplished, include the following:

1. Goals will be established through a modified Delphi technique thus insuring adequate input from many relevant portions of society.
2. Module objectives will be prepared as the modules are developed. An evaluation specialist will have principal responsibility for preparing objective statements. Validity of the objectives will be insured by having the statements verified by module authors.
3. Items for measuring objectives will be constructed by an evaluation specialist. Each item will be validated by the appropriate module author and will be edited for language by a communicator.
4. Base-line data on tryout student aptitude will be obtained from tryout school records. Availability of appropriate aptitude test information will be one criterion for selecting tryout schools.
5. The objective based items for each module will be administered individually rather than as a "test". Interpretation of testing results for a given module will be in terms of the number of students who successfully respond to each item. Where entering level of performance is needed, individual item pretests will be given.
6. Teacher and student opinions will be collected by questionnaire or direct interview. Which response method is chosen will depend upon the proximity of a tryout school to an appropriate project representative.

Monitoring History

The NSF has monitored the progress of the ISIS project through site visits, telephone conversations, and correspondence through the mails.

In December, 1974, NSF appointed a team of three outside reviewers to conduct a substantive evaluation of the ISIS project. The results of these reviewers' findings will be used by NSF staff in its overall evaluation of the progress of the project.

NSF staff members have attended some meetings of the ISIS Advisory Board and have monitored very closely all of the recommendations and actions flowing from this advisory group.

Dissemination/Implementation Plan

Current plans call for completed minicourses to be released in groups of 15 to 20 through the commercial publisher (Ginn and Co.) over the next five years. The first lot of 10 minicourses is scheduled for commercial release in 1975. Each will be usable individually or will collectively form a multidisciplinary science course for average and below average students.

With the release of each succeeding lot of minicourses, the number of possibilities for clustering them into courses of various sorts will increase. Ultimately it is expected that schools will be able to build several varieties of biology, chemistry and physics courses, and that there will be innumerable multidisciplinary course possibilities as well. By 1979 the ISIS project expects to have published enough minicourses to allow schools who wish to do so, to totally replace their high school science programs with one of many locally determined alternatives.

Projected ISIS Timetable

September 1976

Twenty minicourses commercially available enabling schools to offer:

1-year multidisciplinary science programs with a good degree of flexibility.

September 1977

Forty minicourses commercially available enabling schools to offer:

2-year multidisciplinary programs
1-year biological science programs

September 1978

Sixty minicourses commercially available enabling schools to offer:

3-year multidisciplinary programs
1-year biological science pgorams
1-year physical science programs
1-year physics programs
1-year chemistry programs

September 1980

Eighty minicourses commercially available.
Complete management scheme available.

ISIS publishes a free newsletter to keep interested people informed of the project's progress. Also available (for purchase) is a sample set of three of the minicourses now being tested.

Problems Suggested by Detailed Review

1. What kinds of needs assessments should NSF require before embarking on long-term support for national curriculum development and implementation projects? Can the results of a single conference in certain instances serve as a needs assessment? (ISIS resulted from a single conference.)
2. What role should NSF play when supporting feasibility conferences to guarantee that conference participants are really representative of a broad spectrum of ideas for improving the school science curriculums?
3. What should NSF policy be concerning dissemination of conference reports, especially in those cases where conference results are used as a main justification for NSF support of a national curriculum project? (The Callaway Gardens report had limited circulation.)
4. What materials, other than the proposal itself, should be provided to NSF reviewers?
5. Because of the highly interdisciplinary nature of the ISIS proposal and the implications it held for change in the high school science curriculum on a national scale, a mail review of the proposal would seem to be quite inadequate. What should the Foundation's policy be on proposal review systems for curriculum development proposals?
6. In what form and under what circumstances should reviewers' comments be transmitted to the proposer? (Direct quotes of ISIS reviews were provided to proposer.)
7. What should the format be for grant recommendations by a program manager? (Negative reviewer comments were not discussed in as much detail as positive aspects)
8. What should the format be for making grant recommendations to the National Science Board? What should be included? What may be excluded? (ISIS materials provided to the NSB did not describe the details whereby the proposers responded to negative aspects of the reviews)
9. Three minicourses planned for ISIS could be considered by some to be sex education: *Reproduction, Birth and Growth*, and *Human Sexuality*.

Human Sexuality is in a very primitive stage of development and is not yet available for use in the ISIS trial schools. The other two minicourses are in a trial stage and are currently available for use by the trial schools. The procedures for the development and use of these materials should be carefully monitored by NSF. The materials, in their present form, could generate controversy even though there is an explicit disclaimer of NSF approval or disapproval included in the minicourse booklets. There is clear need for NSF policy and procedures to ensure that areas where controversy might be expected are dealt with objectively and openly and that topics of possible concern in various localities are made evident without damaging the scientific integrity of the course material.

Appendix 5

Summary Audit Report on Selected Curriculum Development Projects

In compliance with the request of the Chairman of the review team for pre-college science curriculum development activities, the NSF Audit Office prepared an audit of the financial transactions of the five curriculum development projects selected for case study.

The purpose of this audit was to review, to the extent possible under the circumstances, the financial records at NSF and grantee locations to determine (1) the propriety of direct and indirect expenditures charged to NSF grants, (2) whether the fiscal reports submitted to the NSF were reliable and in agreement with the grantees' records, (3) the adequacy of the grantees' administrative and accounting procedures, (4) whether grant income was handled in accordance with NSF policy, and (5) whether NSF policies and procedures were followed in administering the grant.

This audit included a review of grant records maintained at the NSF and at three grantee locations and a review of prior audits performed by this audit office and by other Government audit agencies. Conclusions from this review of the financial transactions of the five selected curriculum development projects are presented by program.

Chemical Education Materials Study (CHEM Study)

CHEM Study was initiated by Grant G-7656 awarded to the Ohio State University on February 27, 1959, in the amount of $11,500 for the purpose of supporting an "Interim Planning Committee for Chemistry Course Content Studies of High School and General College Chemistry." This grant was completed in August 1959; however, the final fiscal report shows expenditures incurred through June 30, 1960. Since that time, CHEM Study has been supported by the National Science Foundation by grants G-11090 and G-12226, awarded to the University of California, Berkeley Campus (UCBC). These grants continued support for the Steering Committee and provided support for the origination of a chemical education materials study.

A summary of the grant awards is as follows:

Grant	Date of Award	Period	Award	Expended
G-7656	2/27/59	8/59	$11,500	$11,500
G-11090	1/03/60	1/60	9,775	6,457
G-12226	4/01/60	4/01/60 - 11/01/60	125,000	
	6/30/60	one year	350,000	
	10/05/60	25 months	715,800	
	11/01/61	through 8/31/62	956,110	
	1/25/62	through 6/30/63	5,000	
	10/11/62	through 8/31/63	133,400	
	10/29/62		702,925	
	12/05/62	through 10/31/63	145,000	
	6/29/63		(500,000)	
	8/25/64	through 8/31/66	74,800	
	2/07/68	through 12/31/68	36,850	
	8/03/72	through 12/31/72	——	2,728,050
			$2,766,160	$2,746,007*

* Detailed expenditures on file.

During 1966, the NSF Audit Office performed a financial audit of the University of California, Berkeley Campus, with particular emphasis on the CHEM Study project. The purpose of this audit was to determine (1) the propriety of costs charged to NSF grants, (2) whether the grant fiscal reports submitted to the Foundation were in agreement with the University's accounting records and are reliable, (3) the adequacy of the University's administrative and accounting procedures for financial management of NSF projects, (4) the adherence to required procedures for the administration of NSF fellowship and trainee programs, and (5) the adequacy of the accountability for income generated by NSF grant activities. Accordingly, the audit included a review and evaluation of the University's procedures and internal controls insofar as they pertained to NSF grant activities and a review of the expenditures charged to the grants on a test basis.

The audit report is dated December 15, 1966, and indicates that with minor exceptions, UCBC financial administration over NSF grants was performed in a satisfactory manner. Exceptions were subsequently resolved with officials of the University. In view of this prior audit the present review was directed toward UCBC activities subsequent to 1966 as they affected the CHEM Study records maintained by FMO and GCO and discussion of current UCBC financial records with the resident Government auditor from DHEW.

As a result of the prior audit experience and current review, NSF is satisfied that the UCBC accounting records are adequate; that the expenditures reported to NSF are accurate; and that UCBC has complied with NSF requirements and that NSF grants G-7656, G-11090 and G-12226 have been properly closed.

NSF/FMO records indicate that from July 1, 1965, to September 19, 1972, UCBC remitted grant income from sale of publications totaling $4,027,448 to the Foundation; $3,563,794 was deposited as miscellaneous receipts in the U.S. Treasury, and the balance of $463,654 was transferred to the NSF Director's Reserve. Questions of income procedures have been resolved and all income has been satisfactorily accounted for on NSF records.

In conclusion, the Audit Office is of the opinion that the financial records maintained on the CHEM Study properly reflect the financial transactions between NSF and UCBC, in accordance with acceptable accounting practices and in compliance with NSF and other applicable Government regulations.

Science Curriculum Improvement Study (SCIS)

SCIS was initiated by NSF grant GE-600, awarded to the University of Maryland on October 26, 1962, in the amount of $40,250 for the purpose of supporting an "Elementary School Science Curriculum Study." This grant was completed in June 1964. SCIS has also been supported by NSF grant GE-2914, awarded to the University of California, Berkeley Campus (UCBC). This grant continued to support the development of a science curriculum improvement study. A summary of the grant awarded to UCBC is as follows:

Award Date	Period	Award Amount	Expended
9/23/63	9/01/63 - 8/31/64	$99,480	
6/18/64	through 6/15/65	75,000	
8/25/64		154,300	
6/30/65	through 10/31/65	199,910	
10/01/65	through 6/30/67	300,090	
9/65		552,000	
6/29/67	through 9/30/70	176,000	
1/12/68		635,000	
6/28/68		625,000	
6/30/69	through 9/30/71	1,171,000	
6/29/71	through 6/30/73	138,455	
6/25/72		160,000	
——	through 12/31/74		$4,178,182
		$4,286,235*	$4,178,182**

* Does not include $40,250 U. of Md.

** Detailed expenditures on file.

As previously indicated, during 1966 the NSF Audit Office performed a financial audit of the University of California, Berkeley Campus. In view of this audit, the present review was directed toward UCBC activities subsequent to 1966 as they affected the SCIS project. Accordingly, the review was limited to a review of NSF records maintained by FMO and GCO and dicussion of current UCBC financial records with the resident Government auditor from DHEW.

In the review of SCIS, a difference was noted between grant expenditures reported on the Quarterly Expenditure Report (QER) and those reported on the fiscal report amounting to $110,330. This difference was the result of UCBC's deduction of royalty income from grant expenditures which are reported on the QER; since royalty income was maintained in a separate account (in accordance with the terms of grant amendment 11), the total expenditures were reported on the fiscal report. The terms of grant amendment 11 require that total income receipts and disbursements of royalty income be reported to NSF semiannually; however, these reports were not located in either the FMO or GCO files.

It is therefore recommended that the program office strengthen its income procedures so the required reports are available. Also, income reporting procedures should be made clear to the grantee so that QER reports properly reflect total expenditures from obligated NSF funds (grant awards) to assure that NSF/FMO reports to the U.S. Treasury taken from QER information are correct. Income funds, whether subject to expenditures or not, should be separately maintained and reported. The Audit Office was advised by the grantee that royalty income was reported in technical reports to the NSF Program Manager. The grantee has agreed to send NSF separate income reports. (These were received on April 22, 1975, and are adequate to comply with NSF income procedures.)

UCBC statements on the grant revolving fund were examined. These have been submitted on a timely basis. A summary of this activity at December 31, 1974, is as follows:

Sales	$284,759
Center disbursements	259,506
Fund balance at 12/31/74	$ 25,253

In conclusion, except for the difference in grant expenditures reported on the QER and on the interim fiscal report, and the absence of separate income reports (both of which have been corrected), the Audit Office is of the opinion that the financial records maintained on SCIS properly reflect the financial transactions between NSF and UCBC, in accordance with acceptable accounting practices and in compliance with NSF and other applicable Government regulations.

Man: A Course of Study (MACOS)

MACOS was developed by Educational Services Inc. (ESI) which later became Education Development Center, Inc. (EDC), Newton, Massachusetts, under three grants awarded by NSF. The figures below reflect awards for development by EDC only. In addition the Foundation made grants of $1,073,118 to the Washington School of Psychiatry and Antioch College for evaluation projects; $44,700 to EDC for a history review; and implementation awards in the amount of $2,166,500. A summary of the development grant awards is as follows:

Grant	Period	Award	Expended
GE-1831	2/18/63 - 6/30/63	$91,440	$91,429
GE-2567	6/25/63 - 8/31/64	103,980	103,748
GE-3430	1/05/63 - 9/30/72	4,601,960	4,330,773
		$4,797,380	$4,525,950*

* Detailed expenditures on file.

During 1969 the NSF Audit Office performed a management audit of EDC. The purpose of this audit was to determine (1) the propriety of direct and indirect costs charged to NSF grants, (2) whether the fiscal reports submitted to the NSF were reliable and in agreement with EDC's accounting records (3) the adequacy of EDC's administrative and accounting procedures, (4) whether EDC's procedures for computing indirect costs were acceptable and in accordance with NSF guidelines.

The audit report was dated May 4, 1970. It indicates that, with minor exceptions, EDC financial administration of NSF grants was performed in a satisfactory manner. There was an indication that procedures to evaluate project performance, payroll procedures, and purchasing controls needed strengthening.

In view of prior audit conclusions, the review was directed towards EDC activities subsequent to 1969 as they affected the MACOS project. Accordingly, the review included an examination of NSF grant files for the three grants, a review of the NSF/FMO records, and a site visit to EDC for the purpose of reviewing its accounting records of MACOS since 1969. Also reviewed was the prior audit report of May 4, 1970, and audit files concerning EDC.

Grant GE-3430 has been closed for expenditure purposes and EDC has submitted a final fiscal report; however, GE-3430 has been kept open on NSF financial records in order to provide a means of controlling the income received by EDC from grant activities. The Audit Office is satisfied that EDC has properly controlled, reported and submitted this income to NSF in accordance with instructions given them from NSF.

EDC has reported income to NSF in total; that is, the income is pooled and identification of income to specific grants is not always possible. An estimate based on analysis of details submitted with the income was made by GCO to determine the amount of income and expenditures applicable to GE-3430. This is summarized as follows:

	Totals	Applicable to GE-3430
Total Income	$3,899,536.75	
EDC's Share (1)	314,660.65	
NSF Share	$3,584,876.10	$164,266.23
Authorized for EDC Use	$1,379,857.14	158,926.56
Refund to NSF	1,939,932.04	5,339.67
Held by EDC (9/30/74)	265,086.92	
Total 9/30/74 ..	$3,584,876,10	$164,266.23

(1) Because Carnegie and Sloan supported part of the development of income-producing activities, part of the total income is allocated to EDC.

The Audit Office has reviewed the GCO summary of total income and the determination of the amount applicable to GE-3430 and is in agreement with this summary. Income consists of royalties, sales of films, film strips, course materials, teachers sets, etc.

Although EDC has satisfactorily accounted for expenditures and income, it was noted that action should be taken by NSF on grant GE-3430 (1) to deobligate on NSF financial records $270,000 awarded by Amendment 8 (June 25, 1969) and not used, (2) to obtain from EDC approximately $6,000 of grant income and interest earned in 1970 and not submitted, and (3) to correct the Quarterly Expenditure Report (QER) to reflect the proper grant expenditures as shown on the grantee's final fiscal report.

Amendment 8 awarded $270,000 to establish a revolving fund for the purpose of publishing MACOS from May 1, 1969, to April 30, 1970. A summary of the account is as follows:

Awarded by Amendment 8	$270,000
Receipts from sales	579,347
	$849,347
Expenditures	572,843
Balance	$276,504

EDC receives funds under a letter of credit without direct relationship to a specific grant. The income generated through the activities under grant amendment 8 exceeded the expenses and therefore the $270,000 was not considered to be drawn by EDC; in addition, EDC has not included it in the amount of the total grant award in their final fiscal report. The $270,000 remained, however, as an award on NSF records and was therefore available to EDC.

The Audit Office was of the opinion that the amount of $270,000 should be immediately deobligated so that it would not be inadvertently used by EDC, either on MACOS or (through the letter of credit funds) on any other grant. The $270,000 was deobligated by the Financial Management Officer on April 23, 1975, and it is no longer available to EDC.

The activities authorized under Amendment 8 produced a net income as of September 30, 1970, of $6,504. These funds have been carried in the EDC general funds and have not been included in the "pooled income" accounts. EDC has reported these funds to the NSF at regular intervals, and the final report was sent to NSF by letter on February 12, 1975. The Audit Office recommends that NSF request that this amount be submitted for return to the U.S. Treasury account of miscellaneous receipts.

It is further noted, in connection with the net income of $6,504, that corporate funds on hand in excess of immediate working capital needs were usually invested by EDC. It is recommended, therefore, that EDC be requested to pay interest on $6,504 from September 30, 1970, to the date of submission to NSF, at the rate effective during that period.

Finally, expenditures noted in the NSF Quarterly Expenditure Report for GE-3430 are $3,975.05 in excess of the amount reported by EDC in their final fiscal report. It is recommended that NSF correct the QER to reflect the reported expenditures.

In conclusion, except for those matters noted in connection with Amendment 8 and the QER on GE-3430 the Audit Office is of the opinion that the records of NSF and EDC properly reflect the financial transactions of MACOS, in accordance with acceptable accounting practice and in compliance with NSF and other applicable government regulations.

Political Science Course Content Improvement Project for Elementary and Secondary Schools—Comparing Political Experiences (CPE)

The project has been supported by the National Science Foundation since 1972 by grant GW-6810, awarded to the American Political Science Association (APSA), Washington, D.C.; Indiana University and Ohio State University are subcontractors to the grant. With the exception of the project director, estimated costs for Ohio State University are not specifically outlined in the budgets. Funding has been provided as follows:

	Award Amount	Washington Component (APSA)	Indiana University	Ohio State University
2/15/72 - 7/13/73	$193,100	$17,300	$143,800	$32,000
- 3/31/75	317,900	17,700	300,200	——
- 3/31/75	8,500		8,500	
9/01/74 - 12/31/76	742,400	29,700	712,700	
	$1,261,900*	$64,700	$1,165,200	$32,000

The purpose of the review was to (1) review the expenditures made under the grant, (2) determine that the expenditures reported to the NSF were in accordance with the records of the Association, (3) review the administrative procedures and accounting controls of The American Political Science Association concerning this project to the extent considered necessary and (4) review the income aspects of the grant.

Accordingly, the administrative procedures and financial controls were discussed with the Executive Director and Staff Associate of The American Political Science Association and the financial control records of the Association were examined to verify the amounts reported to the NSF. The scope of the examination also included a review of APSA budgeting procedures, publishing agreements and royalty and income policies. DHEW Audit Agency is the cognizant audit agency for Indiana University and Ohio State University participants under this grant. DHEW has most recently reviewed Indiana University's accounting records and submitted a report dated March 8, 1972, which indicated that the University's accounting system was generally acceptable. This report is on file.

As a result of the review of the financial records of APSA, and based upon the DHEW audit cognizance at Indiana University and Ohio State University, the Audit Office is satisfied that the Association has incurred and reported expenditures properly and that the expenditures are in accordance with the purposes of the grant.

APSA has received $3,280.82 gross income and $756.66 net income from the sales of the monograph entitled "Comparing Political Experiences," from the period May 1974 to March 1975, under grant GW-6810. The Audit Office is of the opinion that APSA has handled this income in accordance with NSF policies set forth in NSF Circular 106.

APSA budgets were generally prepared on the basis of "level of effort" for time periods rather than on specific project activities; as of December 31, 1974, certain budgeted line items were either over or under expended when compared to actual costs. It is the opinion of the Audit Office that APSA should review its budgeting procedures and take steps wherever possible to establish procedures so that specific objectives may be compared with budgeted and actual expenditures and performance. Also noted was the fact that the NSF fund balance and cash on hand as of December 31, 1974, totaled $73,242.14, which was in excess of current needs. APSA was advised to review their cash request procedures and to conform to NSF regulations concerning grant funds.

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* Detailed expenditures on file.

With the exception of those comments concerning the review of project performance and excessive cash on hand, it is NSF opinion that the financial transactions of GW-6810 have been properly handled in accordance with Foundation policies and other applicable Government regulations.

Individualized Science Instructional System (ISIS)

ISIS has been supported by the National Science Foundation since September 1972 by grant GW-7645 to the Florida State University, Tallahassee. The objective of the grant, as stated in the grant award letter, is to provide support for the development of a multidisciplinary high school science system. Funding has been provided as follows:

Date of Award	Period	Amount
9/29/72	9/1/72 - 9/30/74	$290,000
3/05/73		55,000
6/08/73		60,000
8/17/73		772,700
		1,177,700
6/28/74	7/1/74 - 9/30/76	1,694,905
12/05/74		480,500
		2,175,405
		$3,353,105*

* Detailed expenditures are on file.

The purpose of the review was to (1) review the expenditures made under the grant, (2) determine that the expenditures reported to the NSF were in accordance with the records of the University, (3) review the administrative procedures and accounting controls of Florida State University (FSU), and (4) review the income aspects of the grant.

Accordingly, the administrative procedures and financial controls were discussed with the Provost of Florida State University and members of his staff, and the financial control records of the University were examined to verify the amounts reported to the NSF. FSU is under the audit cognizance of DHEW, and therefore the purpose of the on-site reveiw was discussed with the DHEW auditors. Their most recent comprehensive audit report is for the year ended June 30, 1970. In this report, DHEW recommended strengthening FSU grant and contract accounting controls; accordingly, discussions were held with FSU on improvements made in these areas since 1970. The scope of this examination also included a review of ISIS budgeting procedures, publishing agreements and royalty and income policies.

As a result of this review and examination of the financial controls maintained by FSU for ISIS, it was determined that FSU has incurred and reported expenditures in a satisfactory manner; based on DHEW review and the improvements resulting therefrom, the Audit Office is satisfied that the costs are proper and in accordance with the purposes of the grant. As far as it was able to be ascertained, FSU has received no grant income from GW-7645; and that if any grant income should be received it will, according to the Provost, be handled in accordance with NSF policies.

Concerning FSU budgeting procedures for ISIS, the grant is primarily a "level of effort" grant with the ultimate objective of producing, testing, revising and distributing 80 minicourses. The principal investigator advised that the budget amounts were basically estimates which were not supported by detailed documentation except in the case of personnel. The Audit Office opinion is that FSU should be encouraged to identify more specifically the program objectives for the budget period so that better estimates of required funds may be available.

Expenditures reported for the two-year budget period ended September 30, 1974, were $138,646 less than the budgeted and funded amounts. No evidence was found in NSF files, however, that these unexpended funds as of September 30, 1974, were considered in establishing the funding for the subsequent period. Although the investigation indicated the carryover of $138,646 was handled satisfactorily by FSU, the NSF program office should have considered and accounted for this carryover in funding the subsequent budget.

Under the publishing agreement with Ginn & Company, a fund of $425,000 will be established by the company for a Teacher Training Fund. The fund is a fixed commitment by the company and it is not related to sales of minicourses. Costs of teacher orientation and training for ISIS shall be charged against this fund, which will be administered by the author (FSU) and the publisher. According to the principal investigator, NSF has no authority over the use of this fund.

With the exception of those comments concerning FSU budget preparation and NSF actions concerning carryover funds, the NSF Audit Office is of the opinion that the financial transactions of GW-7645 have been properly handled in accordance with NSF policies and other applicable Government regulations.

Appendix 6

Included in these appendix are two studies commissioned to provide background to the Science Curriculum Review Team.

The first study "An Analytical Summary of Knowledge About Curricula Implementation in U.S. Schools" by Linda Sikorski of the Far West Laboratory for Educational Research and Development describes some of the factors that influence the adoption and use of curriculum innovations and explores how some of the findings from studies of the variables have been applied to promote the spread and implementation of specific curriculum innovations.

The second study "Commercial Curriculum Development and Implementation in the United States" by BCMA Associates, Inc., was commissioned to provide professional insight into the interests and practices of the commercial publishing industry in pre-college science curriculum development and implementation. It is almost a mini-history of the impact research and development programs funded by the Federal Government and other sources have had on educational publishers.

AN ANALYTICAL SUMMARY OF KNOWLEDGE ABOUT CURRICULA IMPLEMENTATION IN U.S. SCHOOLS

Linda A. Sikorski

Far West Laboratory for Educational
Research and Development

April 29, 1975

An Analytical Summary of Knowledge About Curricula Implementation in U.S. Schools

Linda A. Sikorski
April 29, 1975

A count of factors that have been found to influence the adoption and use of curriculum innovations would probably reach the hundreds, and isolated effects can usually be altered by introducing other variables which interact with the original ones studied. Nevertheless, certain results are fairly well established at a level of abstraction which gives them some value as guidelines--that is, they have action implications for educational change managers. This paper explores these findings and shows how they have been applied to promote the spread and implementation of specific curriculum innovations. The focus is on implementation, or sustained use, of innovations.

It should be pointed out that researchers have yet to agree on a definition or set of criteria for what qualifies as "sustained use" of a curriculum innovation. There are disagreements regarding how much deviation can be permitted before the original curriculum is no longer the one in use, how much time must pass to qualify as "sustained,' whether the entire curriculum or just part of it must be used, and so forth. In addition to these unresolved definitional issues, there is also the problem that very little high-quality, generalizable research on sustained use has been carried out. Within these limitations, this paper discusses the evidence which does exist, using a broad enough concept of implementation to include most studies where there is some evidence of use over at least a short time period and with at least minimal fidelity to the original curriculum innovation.

While many factors act and interact to promote or impede educational change, it is useful to begin by referring to the form or nature of the innovation itself. It has been fairly well established that tangibility, flexibility, radicalness and disruptiveness of innovations are important. To illustrate, a new science textbook is more tangible than a new approach or method for teaching science. A simulation game which is useable in many ways and in many settings is more flexible and adaptable than a rigidly programmed innovation. Innovations such as Drug Education or Sex Education curricula are considered in many school systems to be highly radical, as compared to say, a new reading program. Moveable classrooms, new organizational arrangements, and flexible scheduling represent disruptive innovations, innovations that don't fit easily into the existing structure.

A series of case studies of the diffusion of educational innovations has shown that tangible, flexible innovations which do not employ unfamiliar or disruptive media or methods are quite readily accepted by schools and quite successfully implemented. (Turnbull et al 1974.) Other investigators have confirmed that non-radical, simple products are more easily implemented by schools (Miller 1974; Widmer 1975; McCune 1974), and numerous studies show a negative relationship between disruptiveness of innovations and the implementation of those innovations in schools. (Lindeman et al 1969; Miller 1974; McCune 1974; Widmer 1975.)

In a review of over 50 studies of innovations (mostly non-educational), Rogers and Shoemaker (1971) show that successfully adopted innovations are more communicable (i.e., observable, tangible), compatible, trialable, and divisible (i.e., flexible and adaptable).

A new math text which has visibility and is easy to understand would be quite "communicable." A concept, such as individualized instruction, usually is not. Similarly, the textbook is likely to be compatible with system patterns and values, where individualized instruction may not fit so easily. An inexpensive series item, such as National Scholastic, is trialable, i.e. can be tried out before a major commitment is made, and divisible, i.e. can be used in part. A complex innovation such as closed-circuit TV does not have as much flexibility.

The action implications are fairly obvious--if curriculum innovations can be developed as tangible, non-radical, non-disruptive, flexible products, schools can adopt and successfully implement them; dissemination efforts can be focused on promotion, to develop awareness and interest on the part of potential users.

However, little meaningful educational change is mediated by products with all of those attributes (a point carefully developed by Baldridge, 1974). Curriculum innovations are usually complex, often abstract, often radical and disruptive, and sometimes inflexible.

The successful implementation of such innovations is generally considered to require a degree of change capability and motivation not typically found in schools. In general, factors found to be important can be roughly grouped in two categories: Planning/Evaluation and Organizational Structure. The implications drawn from findings in those areas usually relate to training for school personnel to assume new roles and conduct new programs; to linkages, or institutional, psychological, or interpersonal ties to outside sources and resources; and to incentives, for change-related behavior and participation.

Factors Associated with a Planning and Evaluation Capability. We are learning that systematic planning and evaluation are critical for educational change. They have been found to relate positively to continued use of innovations adopted by schools receiving Title III assistance (Widmer 1975; Miller 1974), to the number of innovations reported being used in their districts by a sample of 400 superintendents

(Havelock 1974), and to effectiveness of curriculum implementation (in research reviewed by Pierce, 1974).

However, findings in this area are uneven. As regards planning, Widmer (1975) reports that for Massachusetts Title III projects, continuance and the existence of an initial needs asssessment were not related. Schools which carried out needs assessments did not seem to benefit from them.

Crandall (1974) reports that planning doesn't always facilitiate change and that, in fact, it may be used to postpone making an action decision.

The suggestion here is that planning is not automatically helpful, but that it must be streamlined and effective. Very likely the finding reported by Widmer (1975) regarding needs assessment is due to the fact that where needs assessments were conducted, they were done to justify rather than prescribe the "solutions" represented by the innovations being adopted. This kind of planning focus is probably a chief reason that education is so replete with "faddish jargon and shortlived innovations." (Sieber 1975).

Very likely, future research will show that improved planning relates to continuance, in part because it enables schools to transform or avoid what are right now held to be almost insurmountable problems in curriculum innovation. For example, adequate planning in regard to a curriculum adoption would allow for early amelioration of the radicalness of a new product, or for accommodation to its disruptiveness, before these come to generate resistance.

Case studies of alternative schools show that one problem with the movement has been poor planning (Deal 1975). Fairly logical negative outcomes were not anticipated, and when they occurred, survival of the school required retrenchment and systematic planning for further development.

It follows that one of the most important functions for planning is to develop clear, visible change goals. Where goals are realistic, limited, and clearly understood by participants, curriculum innovations are more easily and effectively implemented. (Widmer 1975; McCune 1974; Pierce 1974; Pincus 1974.)

As regards the evaluation function, findings here are also uneven. Despite the empirical and logical evidence for its value, at least four investigators present cautions. Havelock's (1974) survey of superintendents finds a slightly negative relationship between innovations and evaluation. Miller (1974) reports for Title III projects in California that less money allocated to evaluation related positively to project continuation. Havelock speculates that evaluation may serve to dampen the innovative spirit when it documents the limited immediate impact which is characteristic of curriculum innovations. If this is in fact occurring, it can probably be attributed again to poor planning, to the failure by planners to anticipate outcomes realistically, and to prepare participants accordingly.

Pincus (1974) cites the inflated expectations for short-term "experimentation" with educational innovation as a chief reason not only for failure, but for the perpetration of resistant postures on the part of school personnel.

Glass (1975) dicusses another serious problem with evaluation, one he calls "evaluation anxiety." He points out that efforts which should be directed toward installing and implementing innovations may instead be spent in developing defenses. Again, a function for planning is to prepare for and accommodate evaluation, and part of this involves developing constructive and realistic attitudes as well as designing evaluation which is oriented to improving rather than dismantling new systems.

This brings us to a key factor in effective planning and evaluation, which is the early and meaningful involvement of those who will implement change.

Innovation is facilitated by the meaningful and early involvement of those who will implement change and it is seriously hampered when participants are not involved. (Fullan and Eastabrook 1973; Widmer 1975; Turnbull et al 1974; Havelock 1974; Miller 1974; Lin et al 1966; Schmuck et al 1971; Pierce 1974.)

Blanzy (1974) describes the need for active involvement of school staff during innovation/implementation:

> "The staff must not only develop the technical competencies to employ the innovation but be allowed to provide feedback as to its use and effectiveness and must in turn be provided with continuing support." (pp. 46-47).

Studies of R&D products and programs with high impact have shown continuous, open communication with user representatives throughout the developmental effort (Turnbull et al 1974) and the obtaining of early commitment from actual users (Widmer 1975). If the key participants are not meaningfully involved, they may fail to effectively implement change, in certain cases even acting to sabotage it. (Turnbull et al 1974; Hall and Rutherford 1975.)

It is not enough to simply consult with or ask the approval of those who will implement change--rather, they must be actively involved in shaping change, there must be real resolution of conflicts and differences, and there needs to be meaningful collaboration among key actors.

Far West Laboratory studies of school decision-making and problem-solving (Coney, et al, 1968; Chorness, et al, 1968a; Mosher, 1968; Carlisle, et al, 1971); other research (Miles, 1974; Havelock, 1974; Miller, 1974; McCune, 1974); reviews of literature (Chorness, et al, 1968b; York, 1968; York, 1970); case studies of the diffusion process (Turnbull, et al, 1974); and field tests of practitioner-target information packages and systems (Hutchins, 1970; Ng, 1970; Sikorski, et al, 1971; Hutchins, et al, 1970) indicate that significant educational planning and decision-making in schools must be a collaborative effort--an important finding, since schools do not typically exhibit "collaborative norms."

Knight and Gorth (1975) have found that innovators in schools usually comprise a very small group, and there is little spread beyond that. Teachers are isolated from administrators and from each other (Smith and Sandler, 1974; Stiles and Robertson, 1973). This works against the effective implementation of new curriculum innovations.

Organizational Development theorists are concerned with creating climates which are supportive of change, which maximize participation and institutionalize planning capabilities. (Schmuck and Miles, 1971; Schmuck et al, 1972.) This is a formal statement of the notion that a critical precurser to the implementation of complex curriculum alternatives is the instilling or improving of the planning capability, including increased participation. Even at the level of the individual, factors related to innovativeness are usually those which have to do with a person's activity and ability levels; characteristics such as level of education and job satisfaction (Knight and Gorth, 1975). At the organizational level, findings suggest that maturity and experience with innovations are important (Baldridge, 1974; Deal, 1975; Denham, 1971; Widmer, 1975). Thus, as noted earlier, typical approaches to the problem of implementation of curriculum stress training (for example, Tempkin, 1974). The 11 Far West Laboratory case studies (Turnbull et al, 1974) provide empirical evidence that this is important; it is stressed that adequate incentives for both trainers and trainees are vitally necessary.

Tempkin and Brown (1974) summarize the implication of research in this area as follows:

> "R&D delivery strategies aimed at bringing research findings, knowledge and products to the schools have less potential for change than those strategies that emphasize strengthening the capabilities of school districts to actively be responsible for their own improvement." (p. 22)

Factors Associated with Organizational Structure. The nature of the school organization has much to do with the process of curriculum implementation. Baldridge (1974) reports findings from six research projects sponsored by the Stanford Center for Research and Development in Teaching which show that structurally complex and large-size organizations generally are more innovative, i. e. adopt new programs and practices more often. Complexity here refers to the number of specialized units, administrative positions, and organizational subsections, and size and complexity are closely related.

He explains that size and complexity are indicators of the school's capability for absorbing change. This is consistent with the first part of this discussion, which implies that schools which can, do, i. e. that capability for innovation is associated with innovation.

Baldridge's discussion goes on to suggest that structural complexity in schools should be increased, to make them more receptive to change.

However, Zaltman et al (1973) review studies which show that while organizational complexity favors the *adoption* or initial acceptance of innovations, more complex organizations have less success *implementing* change. This jibes with Havelock's (1969) description of complex division of labor as an "inhibitor" of knowledge flow in organizations. Zaltman et al explain that the decentralization and specialization which allow innovations to more readily permeate system boundaries, act against the innovation being able to easily fit existing patterns--further, they suggest that guidelines provided through clear structure and authority are needed by participants in a novel situation. They present evidence that formalization, or the clarity and comprehensiveness of rules and regulations, is positively related to implementation (although negatively related to adoption). This is consistent with Robertson's (1971) finding that programmed innovations are more often successfully implemented.

This is also supported by Deal's (1975) case studies of alternative schools. He found that the reason for crisis and failure of these arrangements lay in their disruption of established authority patterns. Those schools which ultimately succeeded were the ones which adopted an authority structure with role clarity and a definite division of labor. Where the initial structure had been, "do what you please," the new structure was, "do what you and I have jointly established."

Baldridge's (1974) report of a New York case study includes the finding that clear cut authority structures facilitated change. Havelock (1969) describes clear authority patterns as a "facilitator" of knowledge flow in organizations.

Knight and Gorth (1975) report findings that indicate that change can be mediated by organizational sanctions, and they suggest that change roles should be institutionalized such that there are incentives and authority patterns relevant to effective conduct of these roles. This suggestion is not new (see, for example, Carlson, 1965, and later, Baldridge, 1974), and it is consistent with our knowledge that the educational establishment does not now favor risk and innovation, that change participation frequently must be at the expense of spending time accomplishing more accepted goals. (Stiles and Robertson, 1973; Knight and Gorth, 1975.) If incentives and a rationale for it were to be institutionalized, participation should increase.

There is, however, at least one caution in this regard: where authority patterns and organizational sanctions are activated to command change behavior, change may not be sustained over time or may be somehow sabotaged by participants. (Zaltman, 1972; Turnbull et al, 1974; Hall and Rutherford, 1975.) Where participants are acting not through a commitment to the curriculum innovation but rather to achieve some other reward or avoid some negative outcome, change behavior will last only so long as the other outcome remains salient; in addition, it may require vigilance over time. In general, then the motivation for change should include at least some commitment to the change; again, the importance of early and meaningful involvement of users is underscored.

Another aspect of school structure which is related to curriculum innovation is that of external contact. Much reported research confirms that external contact and openness of an adopting system play an important role in change. (Klingenberg, 1966; Tempkin, 1974; Hawkins, 1968; Johnson and Marcum, 1969; Crandall, 1972.)

It seems logical that isolation should work against innovation; certainly this has been found to be true at the individual level, where innovation adoption tends to follow friendship patterns (Carlson, 1965; Eibler, 1965; Hughes, 1965) and professional meetings and interactions are found to be used more by more innovative individuals (Carlson, 1965; Hage and DeWar, 1971).

At the organizational level, Baldridge (1974) reports research findings confirming that organizations with viable linking mechanisms to their environments adopt more innovations.

For one thing, individual schools and school districts often lack the necessary manpower and resources to coordinate and troubleshoot the implementation of complex innovations.

Further, Havelock (1974) found that schools "reinvent many wheels" when they are not in contact with other systems with relevant knowledge and experience. Just as practitioners are often isolated within schools, schools and districts are also isolated, if not so much from influence and pressure groups, then from resource systems (Stiles and Robertson, 1973).

Because of this, there is concern with developing and improving linkage systems to break down isolation. This is partly a mechanical problem, one of setting up communication channels. But it is also a psychological one, since practitioners in many areas have institutionalized isolation, using it for protection (Pincus, 1974).

Thus, we come to the importance of incentives. For curriculum change to succeed, it is important that the incentive structure be geared to openness and risk-taking (Turnbull et al, 1974).

In summary, the factors associated with the success or failure of curriculum innovation have generally to do with aspects of capability and motivation, particularly as regards change planning, and with aspects of organizational structure. To increase receptivity of school systems, change managers have used the tools of training and organizational development, incentives, and linkages.

Operating Models for Curriculum Implementation. Current models for the installation or implementation of specific curricula usually apply principles based on the research reported here. Most of them recognize the importance of training. Many are concerned with improving planning/evaluation capabilities and with incorporating or increasing the early and meaningful involvement of the key actors in change.

Within this general pattern, there are variations. Sometimes training is narrow in scope, involving only the teachers and other individuals who will actually use the curriculum. In these cases, training focuses on instructions for use. On a broader level, training may be aimed at developing general professional competencies, such as evaluation skills, so that use not only of the specific curriculum but of other innovations as well is improved. In these cases, usually the target of training is the entire school or district. Between these extremes, there are a variety of approaches. For example, there may be the goal of improving teachers' basic science knowledge to enable them as users of a science curriculum to do a better job teaching it. Or administrators may receive planning skills which they are expected to use in increasing teacher participation.

Additionally, there are various applications of the use of incentives associated with training or other activities (e.g. coordination) necessary for implementing an innovative curriculum. For example, direct rewards such as financial renumeration or academic credit may be offered. Or, distributors may attempt to instill attitudes conducive to effective change, so that teachers are personally and professionally committed to achieving certain outcomes.

Sometimes distributors require broad participation in decision-making by all parties involved by not allowing schools to adopt without evidence of consultation with teachers. More often, conferences or other vehicles for participation are made available but not required. In some cases, there is no real concern for this variable; distributors may feel this is in the school's area of responsibility.

Most distributors are concerned with establishing linkage, to tie individual practitioners with each other, and to link schools and districts with resource systems. Sometimes regional representatives actively contact and interact with users or potential users; often, they are simply available, usually by phone or mail, to provide training or other implementation assistance. Linkage systems may be extensive, involving many different resource and user systems, or more limited, involving only program users and program developers.

Applications of these principles include models such as the Southwest Regional Laboratory (SWRL) model; the Biological Sciences Curriculum Study (BSCS) Human Sciences Program model; the Model for Individually Guided Education (IGE); a Northwest Regional Educational Laboratory Model; the New School Model; the Educational Extension Agent Model; and a model out of Research for Better Schools (RBS).

The SWRL model for implementation assistance stresses training in program management as well as use, thus addressing the need for planning skills. The developer provides materials and procedures for implementing SWRL instructional programs; the responsibiity for conducting training is mainly local. The developer helps initiate, but the adopting system is expected to take over. Consistent with the findings from research, the system is concerned with the quality of instructional planning as much as with the instruction itself; with initiating and evaluating the program. However, incentives intended to operate for trainers and coordinators, and for teachers (trainees), are mainly organizational sanctions; if the program is adopted, certain roles are to be assigned or designated. There are no clear incentives beyond this, and a system for maintaining organizational vigilance is not specified. Thus, instructional improvement is the main motivator to the extent that it is operating. The earlier discussion in this paper would suggest that obtaining involvement and commitment from all participants will be extremely crucial for this model.

The BSCS Human Sciences Program is a complex and radical curriculum innovation. A diffusion model currently being tested is closely tied to Havelock's (1969) conception of linkages. This model stresses collaboration among users in a social influence system, the ultimate in participation and involvement--including resource systems, linkers, and user systems. All groups affected by curriculm changes--even including parents--are represented on a Dissemination and Implementation (D&I) Team which is conceived as a link between users and developers as well as a vehicle for participation and involvement of user groups. The D&I Center is a resource system for the user, along with other systems such as the government sponsor and the distributor. Thus, the centers are intended to establish effective linkage with schools in their regions, ultimately developing a stable social influence network for collaboration.

IGE and the Multiunit School are two versions of an organizational arrangement for nongraded instruction. This is a complex, disruptive innovation which involves the entire school building. Inservice training is the key to a school's implementation of either version, but it is not the only form of implementation support.

The developers hold conferences with representatives of all groups who will be affected by the innovation (including the community and the school board) prior to the time a decision is made. Thus, there is early involvement by key actors. This does not automatically insure that they will be committed, but there is the hope that schools will not decide to adopt until there is substantial agreement.

Schools deciding to use the system sign formal agreements for inservice training. The developers provide the training through linking agencies, and it has been designed to promote professional growth, as a broad concept, rather than program specific skills. Thus, incentives for trainees have been considered. Trainers receive financial renumeration.

Schools are organized into leagues, in an effort to promote resource and idea sharing.

The Northwest Regional Laboratory Model for Research Utilizing Problem Solving (RUPS) for inservice training for planning skills, zeroes in directly on the need for planning skills. It focuses on training, to instill the capability for implementing RUPS. Additionally, the model involves "do-it-yourself-dissemination," where trainees become trainers. Thus, the model depends on collaboration among participants. Additionally, a network of regional representatives is maintained to provide initial training and as a resource system for users.

There are incentives for network personnel, since they receive financial renumeration for services. However, there are no concrete incentives for trainees to become trainers, and there is no particular provision for facilitating collaboration.

The New School of Behavioral Studies in Education lasted from 1968-1972 and provided teacher training for individualizing instruction in North Dakota. Incentives for developing skills were mainly in the area of professional development for less-than-degree teachers (preservice training). These teachers are expected to use the method and spread the word. Developers found that isolation within schools works against this, so they tried to arrange for more than one teacher from a particular school to take the training together. Also, field agents visited schools--rather than serving as more passive resource systems.

Currently, the method is being carried out by the Center for Teaching and Learning at North Dakota State University. It additionally tries to involve all different levels of the school system in using innovative methods through workshops and other means devised and carried out by regional representatives who act as liaisons.

One approach to the problem that schools and districts are isolated was the Educational Extension Program funded by OE to link schools with relevant resource systems through field agents. Agents also served to help schools improve their planning and problem solving capability in reference to specific problems.

The system never completely solved the problem of incentives for State Educational Agents (SEAs) to serve as linkers or the problem that the system was not used to the extent necessary to demonstrate significant change in schools--suggesting again the need to insure incentives for breaking out of the isolation mode and to develop capabilities for curriculum reform.

A related project is currently being funded and involves the linking of potential users of specific exemplary programs with demonstrators and field agents to conduct needs assessment and other planning as well as to facilitate adoptions and assist in implementation.

The RBS Strategy for IPI (and other RBS programs) is also concerned with strengthening planning for innovation. A network of school districts linked to SEAs provide demonstrations, after training for improved planning skills as well as for implementing the product in question. In addition, they stress evaluation and quality-control, providing the feedback system for monitoring.

RBS recognizes the usefulness of participation and tries to involve everyone in training, planning and needs assessment, and evaluation.

Problems in Comparing Models. It is difficult to assess and compare the effectiveness of these and other models. For one thing, the situations in which they are applied allow little or no experimental control. These are operating models, which deal with different innovations and in constantly changing circumstances. The models themselves are being continually revised. To compare the SWRL and Northwest Regional Laboratory models, for example, would be to ignore the vast differences in the innovations being implemented, the environments being dealt with, the requirements for implementation, the skillfulness with which programs are conducted, all of which may have more to do with outcomes than any of the implementation methods being employed.

A second factor which makes comparison difficult is the problem of determining success. In general, most distributors claim success, basing it on elaboration of favorable cases, if that is appropriate, or on presentation of sales data, if that is favorable. But a weakness shared by all the models is that research on classroom utilization, on what actually goes on at the level of the student, is practically non-existent. In effect, we generally do not know first, how teachers actually use these curricula, i.e. whether they teach all or part, how faithful they are to developer's strictures; and second, how these curricula influence student behavior. Developers frequently have not really defined what teachers should be doing, and researchers--partly for political reasons and partly because of methodological inadequacies--shy away from using measures of student outcomes to document the success of programs. There are exceptions--for example, the Far West Laboratory's Minicourses are being researched for effects on students--but, in general, researchers and developers both have avoided questions about student outcomes.

Another major weakness generally shared by the models has to do with how individual and group commitments can be strategically developed and systematically maintained. Right now, this kind of commitment is frequently accidental, based on coincidence of the program with strong user values. Particpation and involvement are usually necessary for commitment, but these are not sufficient. There are not yet good answers to the questions, how do you get the commitment of teachers individually and as groups? How can other key actors be motivated to implement a curriculum alternative? How can school and district decision-making be influenced to favor commitment?

Again, this is a question involving incentives and linkages; incentives are the basis for commitment and linkages are vital for maintaining support and implementation capability. One of the current issues faced by federal policy-makers involves the question: How can projects be influenced to continue when federal funding for incentives and linkages is withdrawn?

So far, the best suggestion researchers can offer for obtaining commitment is to involve users as early as is feasible--in the development stages, if possible--and to be responsive at all development and implementation stages to their particular needs. Additional processes for mediating commitment are not yet clear.

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COMMERCIAL CURRICULUM DEVELOPMENT AND IMPLEMENTATION IN THE UNITED STATES

Prepared by BCMA Associates for the National Science Foundation in response to Purchase Order No. 75-SP-0861 Requisition No. 61422, dated April 18, 1975.

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COMMERCIAL CURRICULUM DEVELOPMENT AND IMPLEMENTATION
IN THE UNITED STATES

Background

BCMA Associates, Inc., is pleased to submit this report to the National Science Foundation in response to Purchase Order No. 75-SP-0867, Requisition No. 61422, dated April 18, 1975.

General Information Concerning School ("El-Hi") Publishing

Instructional materials for elementary schools (pre-kindergarten through grade 6 or 8) and high schools (grade 7 or 9 through 12), customarily referred to as "el-hi" publishing, constitute the largest segment of the educational publishing industry, with estimated annual sales of close to $1 billion.

El-hi publishers develop and market instructional "software" in a variety of media, print and non-print, designed primarily for per-student, per-classroom, or per-school use in public and nonpublic schools ranging from pre-school day-care and early-learning centers to public and private secondary schools providing for a variety of student needs.

Well over half of this estimated $1 billion represents the sale of elementary and secondary textbooks and workbooks (clothbound and paperbound); the balance includes a great variety of other instructional software: non-standardized test booklets; standardized tests; magazines designed especially for instructional use; 8mm, 16mm, and 35mm motion pictures; filmstrips (sound and silent); overhead projection transparencies and masters; duplicating masters; slides; audio tapes and cassettes; phonograph records; study prints; games; manipulative learning aids; miscellaneous boxed materials; multi-media kits.

El-hi sales are understated to some extent, however, because many products not specifically designed for instructional use in schools but nevertheless purchased for such use (e.g. college textbooks; adult and juvenile "trade" books; adult magazines; feature motion picture classics) are not included in the industry's annual statistical surveys made by the Association of American Publishers (AAP) and the Educational Materials Producers Council (EMPC). In addition, the products of a relatively large number of small educational publishers and producers are not fully represented in these surveys.

Although close to $1 billion in annual sales may seem large, it is considerably smaller than the annual sales of each of many dozens of United States corporations, including some that own el-hi publishing companies. Also, when translated into annual sales per student and per school, the figure does not seem nearly so impressive. As reported in the annual AAP survey, for example, the per-student expenditure for printed instructional materials in 1973 was approximately $10.35.

The largest percentage of el-hi publishing revenues comes from the sale of basic instructional programs in the major disciplines, published by the school divisions of large (in terms of the industry) publicly-held companies, or by el-hi companies that are subsidiaries or divisions of non-publishing corporations. The industry provides ample room, however, for many much smaller companies that develop and market new products (often innovative, sometimes of very high quality) with speed, ingenuity, an eye for special instructional needs, and a modest initial investment. El-hi publishing, in fact, consists of a relatively large number of relatively small companies.

This aspect of el-hi publishing is well illustrated by the following representative list of 43 companies, all of which are important factors in one or more subject-matter or basic-skills areas in el-hi publishing. They range, however, all the way from small, independent firms to relatively large school divisions or subsidiaries owned by much larger parents, some of them non-publishing corporations. For convenience, we have listed all these 43 companies and divisions separately on the next page (3).

The 12 companies starred are generally considered to be among the largest el-hi publishers of basic instructional materials (though not necessarily the largest publishers). All 12 possess the ability, the resources, and the inclination to develop and disseminate basic multi-media instructional programs that require the expenditure of up to several million of their own development and production dollars, and up to five years or more of effort, before a single item is sold. The entrepreneurial boldness of many smaller companies, however, is indicated by the fact that a very small publisher (not even on the above list, but known to the authors of this report) raised the necessary funds and spent about $750,000 over a period of three years to create and place on the market an alternative basic reading skills program for grades 1 to 8.

*Addison-Wesley

Allyn and Bacon

American Book Company (Litton)

AMSCO

Benziger Bruce & Glencoe (Macmillan)

Bobbs-Merrill (ITT)

Economy

Educational Development Corp.

Encyclopaedia Britannica
Educational Corp.

Fearon (Pitman)

Follett

*Ginn (Xerox)

Globe (Esquire)

*Gregg Division (McGraw-Hill)

Grolier Educational Corp.

*Harcourt Brace Jovanovich

Harper & Row

D. C. Heath (Raytheon)

*Holt, Rinehart & Winston (CBS)

Imperial International Learning

Laidlaw (Doubleday)

*Houghton, Mifflin

J. B. Lippincott

*Macmillan

McCormick-Mathers (Litton)

Charles E. Merrill (Bell & Howell)

National Textbook

Noble and Noble (Dell)

Open Court

Pflaum (Standard Publishing)

Pitman

Prentice-Hall

Rand-McNally

Random House School Division (RCA)

William H. Sadlier

*Science Research Associates (IBM)

Scholastic Magazines

*Scott Foresman

*Silver Burdett (Scott Foresman)

*South-Western (Scott Foresman)

Steck-Vaughn (Intext)

*Webster Division (McGraw-Hill)

Westinghouse Learning Corp.

Xerox Education Publications

Changes in El-Hi Publishing

Within the past 17 years, dating from the pressures generated by post-Sputnik reactions to educational problems, the el-hi publishing industry has become transformed from publishers of "printed materials of instruction" -- basic clothbound textbooks (with correlated workbooks, test booklets, and teachers manuals) arranged in a graded series (e.g. elementary reading) or for a course (e.g. high school biology), and "supplementary materials" (e.g. classroom periodicals, paperback books) -- into publishers and producers of multi-media instructional programs and systems. Both large and small el-hi publishers have been affected by this change, even those that are usually classified as publishers and producers of supplementary materials designed for "building-level" sale.

In addition to the catch-up-with-the-Russians pressures noted above, the major factors that have led to this dramatic change in el-hi publishing include: the interest (dating from about 1960) of large, technologically-oriented, non-publishing corporations in educational publishing; the impact of programmed instruction and teaching machines; the great number of government-funded curriculum projects; advances in "audio-visual" technology; the emphasis on developing materials in a variety of media suitable for use with culturally-deprived minorities; the emphasis on individualized learning; an increasing demand (led by the states of California and Florida) for publishers and producers to display valid evidence of the "learner verification" of instructional materials being offered for adoption (particularly those materials concerned with the development of "basic skills" in elementary language arts -- reading especially -- mathematics, social studies, and science).

Reflecting these influences and changes, the American Textbook Publishers Institute became the American Educational Publishers Institute in the mid 1960's and later the School Division of the Association of American Publishers.

General Characteristics of Instructional Programs

As used in this report and by el-hi publishers, basic instructional materials programs include all the components of a program produced to implement the curriculum in a subject such as elementary reading, elementary science, secondary school mathematics, or secondary school literature. The components for an instructional materials program for a curriculum in the elementary school may include a textbook for each grade, with a series of correlated workbooks and teachers' editions, or it may now be a multi-media program that includes a wide variety of instructional materials including not only textbooks for each grade but also correlated sound filmstrips, simulation games, posters, duplicating masters, special materials for individualized instruction, and other components.

Although the components of an instructional materials program differ according to the subject for which they are intended, the learning theory underlying the program, and the publisher's design, most large instructional programs are now multimedia in scope. It should be noted, however, that such programs usually are organized around basic textbooks, whether they are single books for each grade or subject, or multi-books.

It also should be pointed out that the textbook is usually the catalytic agent of an instructional materials program not only for educational reasons but also to conform to the regulations of the states with statewide textbook adoptions or listings. In the 22 states with statewide adoptions, the call for bids usually includes only textbooks and teachers' editions, which the state may supply to students without cost. The district may purchase the correlated materials. To meet state regulations and also to provide textbooks for selecting committees that want them in a more flexible form, publishers sometimes publish the textbooks in two forms: a single clothbound textbook for each grade, and as a series of unit textbooks for each grade. The states with statewide adoptions are, however, beginning to close the gap between curriculum trends involving a system of materials and the regulations that are restricted to textbooks and teachers' editions only.

Evolution and Revolution

This change from a single basic textbook in each grade for each subject to mulit-media instructional materials programs has considerable relevance to this report because it is transforming, perhaps revolutionizing, all aspects of el-hi publishing. For example, the development and production of a program of educational materials requires careful planning to make certain that the whole is greater than the sum of the parts. A multi-media program also requires careful planning to make certain the components are developed, produced and delivered on schedule. Their development also increases the need for classroom testing and at the same time complicates the process. The production and packaging of the materials to facilitate distribution to pupils as they are needed and their retrieval and storage after the pupils have completed their use of them, demands new procedures.

Not only has the change transformed development, but it also makes new demands on the publisher for implementation. For teachers to use the materials to their best advantage, the system requires carefully prepared teachers' editions and demonstration workshops. This change also is encouraging publishers to think of themselves not only as publishers of instructional materials but as agencies for curriculum development and implementation. A well-known publishing firm with a distinguished reputation, for example, has recast the editorial department into two Centers for Curriculum Development - one located in San Francisco, the other in New York City.

And, last but not least, the production of a program of multi-media instructional materials requires of the publisher a much heavier investment of capital both to develop and to produce the programs.

The Structure of El-Hi Publishing

The following brief, highly generalized description of the characteristic structure of el-hi firms reveals how they are organized to carry out the two functions of the development and implementation of instructional materials programs.

Although each el-hi publishing firm has its own pattern of organization, the functions they perform in a sense dictate organizational structures with many common features - found in virtually all companies. And all el-hi publishing organizations reflect the organization of school curricula.

An el-hi division is usually headed by a general manager or department head. The functional organization usually includes an editorial director who is responsible for the development and production of the instructional materials programs. For each curriculum area for which the publisher publishes, there is usually an editor-in-chief. For example, an editorial director may have reporting to him an editor-in-chief in language arts (with perhaps a separate editor-in-chief for reading), an editor-in-chief in science, one in mathematics, one in social studies, and perhaps an editor-in-chief in foreigh languages or industrial arts or home economics. The number of editors-in-chief depends, of course, on the publisher's areas of concentration.

Editorial

The editors-in-chief not only actively engage in development, but they also have their own staff of editors to whom they assign projects. The number of editors in a subject-matter area depend, of course, on the publishing program. A subject-matter editorial department that has an elementary reading program under development may have as many as thirty editors working on that program alone.

The curriculum areas may be further divided into elementary and secondary, with separate editors-in-chief for each -- e.g. elementary language arts, secondary language arts, elementary mathematics, etc.

The qualifications of subject matter editors, especially of the editors-in-chief, reveal a great deal about the role of educational publishers in the development of instructional materials. The editor-in-chief of each discipline, for example, and members of his staff, are continually engaged in keeping up to date on the scholarly research in the fields of their specialization, on the recent and current studies of curriculum committees and commissions, on theories of learning (especially those of Piaget), and on the external forces that influence curriculum, such as the demands for reform by minorities for accurate representations in instructional materials of their role in history and of their achievements and aspirations, and by the women's rights movement. To these latter forces they must be especially sensitive. As members of professional organizations, such as the National Science Teachers Association, they not only read their publications and attend their meetings, but they also often contribute to the publications and participate in their conferences. They are educators and scholars who specialize in the development of instructional materials.

In addition to the necessary skills required of any editor, they usually have had teaching experience in the subjects for which they are responsible, and often publishing experience that may include selling as well as editing instructional materials. Almost all hold graduate degrees either in a discipline or in the teaching of the subject. Many of them include in their experience staff work on curriculum research and development commissions or committees. In their approach to the development of instructional materials, they can be characterized as pragmatic idealists.

Production

Another important function in el-hi publishing is production, usually under the direction of a production manager, who sometimes reports to the editorial director and sometimes to the department head. The production department acts as the liaison and the negotiator between the publisher and the suppliers of the many different kinds of materials and services that go into the manufacturing of an instructional program: paper; cloth; printing; binding; slide, film, phonograph record; and audio tape manufacturing; packaging, etc. These materials and services are supplied either under contract or in response to competitive bids. The production department also is responsible for working with the editors in designing instructional materials, providing necessary art work, finding suitable photographs and other illustrations, and in designing attractive book covers, and also boxes of various kinds to accommodate the non-book materials in the program. Cover and box design is a special function that may seem relatively unimportant -- but not to the initiated!

Usually (especially in the larger houses) the editorial department includes a copy-editing staff. Copy-editors are responsible for preparing the manuscripts for the printer. They make certain the punctuation is uniform and the spelling is correct, and mark the pages for type. They also check the statistical data and make certain the tables are correct. If they discover passages that seem too difficult for the reader, they refer them to the editors for revision.

As this description indicates, the development of instructional materials requires the specialized efforts of a large number of highly qualified technicians who often combine in one person editorial and teaching experience.

Marketing

Each publishing division also includes a marketing staff headed by a marketing director. Since marketing and development are closely related, the editorial and marketing directors work together in overall planning and in decision-making. The marketing director may have a national sales manager who reports to him, along with a manager for advertising and promotion. Also, the marketing director will of course have the major responsibility for dissemination and implementation.

Consultants

He usually has on his staff a team of consultants and a team of product managers. Both consultants and product managers play an important role in dissemination and curriculum implementation. The consultants, who also have a teaching and supervisory background, perform at least three important functions in the educational publishing process: they act as consultants to the editors; they interpret the instructional materials (especially the underlying learning theories) to selection and adoption committees; they help to implement the use of the materials by holding workshops, classroom demonstrations, and seminars for teachers using them.

Not only do the consultants implement the use of the instructional materials through their seminars and demonstrations, but they also have the benefit of the teacher's evaluation of the instructional materials they use. With the feedback from teachers combined with their own experience, their contribution to editorial development is invaluable.

The contribution of the consultants to the implementation of the curriculum is a part of the service the publisher provides to the districts without cost, except as reflected in the prices of the materials being sold. Because of their contribution and their success in the implementation of the curriculum materials, the boards of education and administration of many states and districts make the provision of consultants a part of the adoption agreement.

Product Managers

In educational publishing, the product manager is a relatively recent addition to the marketing staff. The role of the product manager is to interpret the educational materials to the salesmen and to make the presentations to selecting and adopting committees. In addition to his role in marketing and implementation, he also interprets the trends, especially those from the field, to the subject-matter editors. Product managers, like editors-in-chief, concentrate their efforts in their field of specialization. For example, there are product managers for social studies materials, for science instructional materials and for other subject-matter areas.

The need for product managers reflects the transformation in educational publishing from single basic textbooks to multi-media programs involving new learning theories. To grasp the learning theories in an instructional materials curriculum program, to understand the inter-relationship of the components in a program, and to interpret those theories and interrelationships to the marketing staff and teachers, requires the efforts of a specialist who combines in one person the knowledge of a curriculum specialist and the ability to interpret that knowledge to salesmen and teachers.

Sales Managers

As we have mentioned, the marketing director usually includes on his staff a national sales manager. For each region there is usually a regional sales manager who reports to the national sales manager. The regions usually include the Pacific Coast, the Middle West, the Southwest, the Southeast, and the Northeast. Each region includes a sales staff that reports to the regional sales manager. The field staff in the region is responsible for the dissemination of their company's instructional materials to school administrators, supervisors, department chairmen in the secondary school, and to teachers.

Sales Representatives

The field sales representatives of almost all publishers of curricula materials make sales calls on teachers, supervisors, and administrators at least once or twice each year (sometimes more often) in the districts that enroll 90% of the students. During these interviews they make a presentation of the learning and teaching features of the instructional materials they represent in the areas where materials are being selected and adopted that year in a particular state or district. Not only, however, do the field representatives keep the educators informed about curricula trends and instructional materials to implement them, but they also learn about educational trends as reflected in their conversation with teachers. They also receive the teachers' evaluations of the materials they are using combined with the report of teachers on new curriculum materials they would like to have developed for them.

These reports they submit to their sales managers, who collate them as guides for the editorial staff and marketing director. For the educational publishers the sales staff combined with consultants provides a daily nationwide feedback of the grassroots evaluation of instructional materials in use and of instructional materials needs. They form a communications bridge between the educational community and the publishers. Thus, the sales staff and the consultants provide an important input in the publishing decision process. This input, combined with scholarly research in a discipline or the fundamental research in the learning process, is the thread that forms the pattern of instructional materials development.

Plans and Projections

The process for the development of instructional materials in many firms begins with short-range and long-range planning. In many el-hi publishing companies the planning takes the form of a five-year and ten-year projection. This projection includes an annual schedule for the launching of new and revised instructional materials.

programs, such as elementary science or secondary literature, and instructional materials for single subjects, such as high school biology. For example, the year 1976 for a company might mark the launching of a new program and the revision of several already in production.

The plan would also indicate the publishing schedule with the copyright dates of a new and revised program. The decision, however, as to the time required to bring the revision or the new program from idea to printed page is based on the conventional wisdom that a thorough revision requiring new plates will take at least three years and a new program will require at least five years from the signing of the contract until the program is completed and is ready for dissemination to the classrooms. Since these time periods represent the averages, many programs may require a longer period than the schedule calls for, and others less. A program that requires a longer period than scheduled, however, may jeopardize sales because the publishing dates are correlated with adoption dates, at which time teachers and administrators have the opportunity to select and adopt programs with a new approach.

Some of the adoption dates are determined by state and city regulations. Also, when the selecting and adopting committees are in the process of changing their curriculum from a traditional to a modern approach, a company that publishes a modern program, regardless of its merits, may lose out because the program is published after the districts have adopted programs with the new approach. For the instructional materials publisher, the importance of timing is difficult to over estimate.

In planning the publisher also makes a tentative estimate of the editorial staff required to develop the programs during each year of the plan. Since the plan may call for growth, it will indicate the additional staff the manager will need to recruit and train.

To keep the plans up to date, they are usually reviewed and revised annually. Although the plans need to be kept flexible if they are to take advantage of educational trends and publishing opportunities, they do provide the publisher's staff with development guidelines. For one thing, they indicate the revenue that is likely to be available for the development of new and revised programs. Another advantage is that they focus the efforts of the staff on the programs included in the development plan. And a third, and perhaps most important advantage, is the lead time they give the staff, especially the editors, to thoroughly research the curriculum studies, the learning theories, and the programs currently available and the trends in the fields of their specialization, and to be on the lookout for authors. From this research, the editors have a better opportunity to visualize what the curriculum trends may be five or ten years from the present, rather than rest their decisions on the current state of the art. To paraphrase John Maynard Keynes, the editor has the opportunity to study the present in the light of the past for the purposes of the future.

The preparation of a plan, it should be pointed out, offers many a special advantage because it involves the entire staff, including the consultants and the field staff, which may number more than a hundred salesmen. Because the sales staff, including the consultants, are involved in the planning, they become more alert about identifying prospective authors and outside consultants, and in identifying school districts where field testing would be welcomed by the administrators and teachers. Planning is a part of the process involved in developing curricula instructional materials. It provides the background for a description of the steps involved in the process of developing instructional materials from planning to production. To this process we turn next.

From Planning to Production

Up to this point, we have included a generalized description of the transformation of educational publishing from textbook publishers to Centers for Multi-Media Curriculum Development; a generalized description of the structure of educational publishing firms (especially as the structure relates to development and implementation), and a description of five and ten-year planning. We now turn our attention to the specific development of a program from planning to production, with some reference to implementation.

As we have already indicated, a five and ten-year plan provides some guidelines for decision making provided, of course, the revenue and profitability forecast lives up to expectations. Regardless of long-term plans, publishers are always faced with decisions as to how best to use their staff and allocate their resources. If a publisher has over a considerable period of time built up an experienced staff in several subject-matter areas, then management is more likely to allocate resources and to use the staff to revise programs already in production and widely disseminated and to develop new programs in the same fields.

Whether or not a publisher publishes in a limited or in an extensive number of fields, management always must decide how to allocate funds and utilize staff to best advantage. For the purposes of this topic, we shall assume that the management has made a decision to develop a new program either for the elementary or secondary schools, since the stages for both follow similar paths.

During the decision-making stage, the first recommendation to publish a new series may originate at several sources, either outside or inside the firm. It is very likely to originate with the editor-in-chief of a subject-matter area, such as science or mathematics, and his associates after they have conferred with the marketing director and his staff. The recommendations may originate with the marketing director and his staff who take it to the editor-in-chief for exploration. Since the reasons that prompt the decisions reflect each publisher's special need or opportunity, they do not lend themselves to simplistic generalization. It is always true, of course, that publishers allocate their funds and assign their staff to those programs which in their opinion will enable them to compete successfully in the instructional materials marketplace.

They may be guided in their decisions by a desire to develop materials that will compete with programs developed by research and development study groups or councils. These programs, perhaps more than any other single factor, have influenced the development decisions of instructional materials publishers. The feedback from the sales staff also provides the basis for a publishing decision.

If an outstanding specialist in a subject-matter field approaches the publisher as a prospective author with innovative ideas for a new series in an elementary or secondary subject, such as mathematics, or for a one-semester or two-semester course, such as United States history, the publisher may decide to accept the proposal. Thus, the proposals of prospective authors influence the decisions el-hi publishers make.

If an editor with a firm develops a curriculum proposal with innovative features that will meet instructional materials needs and trends, or perhaps foresee trends, his ideas may be the main basis for a publishing decision.

With their marketing and editorial staff, educational publishers are also continuously engaged in market research. This market research supplements the curriculum research and development by both study groups and by the publishers' curriculum centers and editorial departments.

Once the management has approved the development of a new program, the development may take place in the following stages.

In stage one of the editorial process the editor-in-chief and his associates decide (whether the instructional materials program is a series of a one-year subject) to build an informal criteria for the program, whether it is for a series for several grades or a one or two-semester course.

In stage two, or in stage one, because these stages are interchangeable, the editor and his associates decide on the type of authorship they want for the series.

It is more or less typical for a series to include one or more general editors outside the firm, a staff of authors (frequently one or more authors for each grade or subject), and a staff of outside consultants. In all cases, the general editors are distinguished for their research in the field both in methods and in content. As a rule, they hold positions in distinguished universities as professors of education, or chairmen of departments of education of the subject for which they are chosen. Since general editors will also assist in selecting the authors and outside consultants and in directing their efforts, their management experience and acquaintanceship with teachers who have author possibilities are qualifications the pblishers also seek.

Once the publisher has recruited one or more general editors and reached an agreement with them, the next step usually is a planning conference between the publisher's editors and the general editors for the series. At this conference, they will develop a tentative scope and sequence chart, and perhaps identify the major concepts to be developed. In the publishing of a series, the development of a scope and sequence chart, including the spiral development of concepts, is perhaps the most important single undertaking. It may be the hinge upon which the series swings. At this stage, the scope and sequence chart also helps the series planning group to identify the authors they hope to recruit to write the manuscripts and develop the components.

In the authorship the editors try to identify prospective authors who combine in one person or in more than one these qualifications: classroom experience, teacher education experience, knowledge in depth of the subject matter, of leraning theories, and of research studies.

As outside consultants, the publisher's staff and the general editors try to identify both classroom teachers and specialists in methods and in the subject matter to assist in planning, in reviewing the materials as they are developed and, if they are classroom teachers, perhaps in trying out some of the materials in their classrooms. A secondary consideration in the selection of authors and consultants is geography. Since instructional materials are published for a nationwide market, a nationwide authorship is a consideration in the selection of authors and consultants. The overriding consideration, however, is the author's ability to produce materials of excellence.

If the movement for learner verification continues to grow, no doubt publishers will also identify teachers who will assist in the development of the materials by using them in their classrooms under the standards required for learner verification. Since several publishers are already supplying data on the learner verification of programs they have developed and produced, this trend in el-hi publishing seems already to be well under way.

At this conference between the publisher's staff and the general editors, the participants are also likely to develop a tentative list of multi-media components for the program and identify teachers or producers to develop both the scripts and the specifications for them.

At the next stage the editor-in-chief of the project will probably undertake two steps at the same time: he will invite the authors and consultants to participate in the project, and he will begin to develop the specifications for an estimate of costs. With the invitation to authors, he may suggest to them that they prepare a sample chapter as a prerequisite to a contract. For both author and publisher, this exercise has advantages. For the publisher, the sample chapter indicates the author's ability to prepare material for publication. For the prospective author, the chapter reveals to him the preparation time the chapter involves and also something about his capability to undertake the task.

During this stage or before, the editorial staff for the program will develop the specifications for the production managers to use in estimating costs. These specifications will include trim size, number of pages for each pupil's book and teacher's editions, the number and type of illustrations, and the use of color. The editor-in-chief and his associates will also develop specifications for the components. These specifications will also provide printing estimates for printed materials and production estimates for non-print components.

At the same time, and in conjunction with the marketing director, the editor-in-chief and associates will develop a one-year and a five-year forecast of sales of each component. On the basis of production estimates and forecase, the management can determine a unit price to cover amortization costs, author's royalties, printing and binding costs, and operating costs, with a gross profit compatible with the firm's policy.

With these specifications the production manager of the program will secure comparative costs for the printed materials from printers and binders and comparative costs for non-print components from the producers of these materials.

If the per-pupil cost of the materials does not fall within the limits of school budgets or is excessively out of line with the cost of comparable competing programs, the management will request the editor-in-chief to reduce his costs without sacrificing his major goals. Often this can be accomplished.

This simplistic description of the business arithmetic required in planning a program, whether a series or a program for a one-year subject, such as United States history, obviously cannot include every detail. It does, however, make the point that instructional materials programs are carefully budgeted at the time they are launched, and the costs regularly reviewed throughout the period of development.

A Special Note about Costs

The costs discussed here include only those that usually come under the heading, in publishers' accounting systems, of "cost of goods sold" -- "plate" or "plant" costs (non-recurring pre-publication costs); production or manufacturing costs (the creation of saleable inventory); and royalties. They do not, however, normally include staff salaries and other overhead (rent, light, heat, etc.).

"Plate" or "plant" costs are non-recurring, pre-publication development costs. They generally include everything that is paid to people outside the firm to create the printing plates, master tapes and films, dies, etc., that are needed to manufacture multiple copies of all the program's components. Sometimes the initial manufacturing runs to create inventory (since this inventory is often used mostly for examination copies) are included in plant costs, but more often they are not. The various plant-cost items mentioned above, which obviously vary greatly from project to project (and from accounting system to accounting system!), are comparable to the machine tools of industrial manufacturing. The cost of these items is the seed money that must be amortized within a reasonable period (usually from two to five years) in the pricing and sale of a program if it is to be financially successful.

Most educational publishers experiment from time to time with the allocation of all costs (including editorial, production, and administrative salaries, and a share of overhead) to plant costs, but most such experiments lead eventually to frustration. The procedures that must be set up are complex and time-consuming, and the results usually are distorted, because of disagreements about proper allocation, and simply because most editors and production people find it hard to fill out time cards! Nevertheless, publishers quite properly persist in attempting to set up realistic cost accounting systems for major projects.

The above analysis indicates why it is often difficult for anyone (even the publisher) to say *exactly* what has been spent on the development of a particular program. As a rule of thumb, however, it is probably true that for every dollar spent on "plant" costs another dollar is spent on in-the-house overhead, including especially editorial, production, and administrative salaries. That is why a publisher may say that a particular elementary reading program for grades K-6 cost about $2,500,000 to develop, but, he hastens to add, "when you consider all our out-of-pocket expenses before a single item was sold, it was probably closer to $5,000,000."

As to the average total cost of developing a basic, multi-component, multi-media instructional materials program, it can vary all the way from about $400,000 to $500,000 for high school biology up to $6,000,000 (and even higher) for a per-K to grade 8 elementary reading program. These total estimated costs include overhead, but not the creation of initial inventory.

Writing, Rewriting, Artwork, Classroom Testing

After the full staff of authors and consultants have been recruited and the budget approved, the publisher usually brings the editorial staff involved in the program, including the general series editors, and the authors and perhaps outside consultants, together for a working conference. At this conference authors and editors review and revise the scope and sequence and develop the underlying teaching and learning ideas for them.

Here the editor and his staff will set the targets for the development of the manuscript, including the teachers' editions. As the first target, the editor is likely to set the completion of the first chapter. As he receives these chapters, he sends duplicates to the general editors and to the outside consultants. By setting the manuscript for chapter one as a target, the editor gains an insight into the work habits and general competency of the authors. If the reviews of the general editors and of the consultants indicate a chapter requires revision, it is better to return a single chapter for revision than a complete manuscript.

With the first chapter in hand, the design department can begin to develop art work and collect illustrations. Also, the production manager can estimate length. Thus, the author has a guideline to follow in writing the remaining chapters of the program.

Each chapter of each book may be written, revised and rewritten as many as three or more times before it is ready for the copyeditor. During this time, the authors have had the opportunity to review and recommend revisions of all art work, and teachers and outside consultants may have tried out parts of the manuscript with their own pupils, if not with all the pupils in their school or district. The outcome of the classroom use of the materials the teachers include in their reviews.

Although there are many factors that create the need for writing, revision, and rewriting, the identification of concepts and explanation of concepts at their point of introduction and their spiral development from grade to grade are overriding factors. The scope and sequence charts that the authors and editors prepare almost always includes the concepts emphasized at each grade level.

For a series of a single program to have the benefit of the development along the lines as described in this report usually requires a minimum period of five years from planning to production. However, a crash program may reduce the period by a year or two.

The Challenge of Implementation

With the advent of multi-media instructional materials programs reflecting new learning theories and the best of modern scholarship, publishers are faced with new implementation challenges. In a sense, the implementation of their new curriculum materials requires the recycling of teachers teaching the new program, including the education of the teacher in some of the content of the subject. A new social studies program with its interdisciplinary approach, for example, may draw a considerable amount of its content from disciplines not included in the teacher's undergraduate and graduate program of studies.

The multi-media program also makes new demands on the teacher for the storage, retrieval, and distribution of the materials, especially if these are adapted for individualized instruction, and for the use of media that may be unfamiliar. It is still true, for example, that most teachers are all thumbs in operating a filmstrip or movie projector.

To these challenges of implementation, if the materials are to be used to their best advantage, the publishers are responding in a variety of ways including these:

- They are, for example, not only developing teachers' editions to accompany the textbook, but they are also developing teachers' guides for each of the components. These editions and guides are a necessary and important part of the publisher's implementation of the curriculum.
- They also make available to the instructional staff in districts adopting the program the services of consultants. These consultants may be either attached to the publisher's staff or teachers who have had experience in teaching the program as it was developed. The authors of the programs are often available as implementation consultants.
- Summer institutes sponsored by the publisher may also be a part of implementation efforts for certain programs.
- Some publishers also develop implementation bulletins that they send out periodically to the teachers who request them.

Although these efforts are in the right direction, they may not be equal to the challenge of new curriculum materials with their new approaches to teaching and learning and with content frequently not included in the teacher's undergraduate and graduate curriculum. The publisher's efforts to expand implementation beyond their present efforts is limited by the money available in school budgets. Many publishers are convinced that the programs they develop with a heavy investment of their own funds, as well as the programs developed by Study Groups and Councils, do not always live up to expectations because of the cost limit imposed on implementation.

The Impact of Federally-Funded Curriculum Projects

As noted on page four and elsewhere in this report, federally-funded curriculum projects (along with a number of association-funded and foundation-funded efforts) have been one of the particularly significant change agents in el-hi pbblishing since the late 1950's. Although BCMA Associates cannot, of course, act as definitive spokesman for the industry in commenting on this complex topic, we nevertheless offer in this section of our report some observations, based on a wide range of personal experience, on the impact these curriculum projects have had on el-hi publishers.

Since el-hi publishers are by nature highly individualistic, highly competitive, and free-enterprise-oriented, many of them expressed concern, when the federally-funded projects were first announced, about the role of the federal government in subsidizing the development of instructional materials. Many believed that it would be more appropriate to spend equivalent funds on educating teachers to bring them up to date on new methods and recent scholarship, rather than on the development of textbooks and related materials. Others thought that materials created with taxpayers' money should be in the public domain, not copyrighted and licensed to a single commercial publisher, but made available to all as models. Others were genuinely skeptical about how much innovation school authorities, with their limited budgets for instructional materials, would buy.

Many el-hi publishers were also concerned about the development of programs that would not have the input of the publishers' professional editorial and production staffs. As responsible publishers, they were convinced the projects would benefit from their editorial and production experience as well as from their marketing capability.

Publishers, too, did not want to be placed at a disadvantage because they had to compete against programs where the development costs included not only field-testing in many classrooms but also teacher education programs that prepared teachers to understand concepts new to them and in addition created a built-in market for the curriculum materials when they were published.

At the same time, however, all thoughtful and responsible el-hi publishers were aware that many aspects of the curriculum, at all levels and in all subject areas, were in need of change and improvement, and that as commercial publishers they simply did not have the financial resources nor the curricular clout to accomplish some of these needed innovative changes. (The annals of el-hi publishing are studded with forward-looking textbooks and programs that were ahead of their time and yet were failures in the marketplace.)

Though many publishers may have had serious misgivings about the role of the federal government in funding curriculum research and development projects, they were also aware that basic research and development for the improvement of education lagged behind research and development in health, medicine, agriculture, industry and other areas. For publishers as well as professional educators, there were many questions bbout learning and curriculum development that educational research and development could answer. This point of view seems to us as prevalent today as it was in the fifties.

Responsible and thoughtful el-hi publishers also realized that organizations like the National Science Foundation were making a serious effort to bring about desirable changes in the curriculum through the creation of new kinds of textbooks and other materials because they believed that change would come about most quickly in this way.

This point of view Dr. Keith Kelson voiced in a conversation several years ago with an educational publisher, when the publisher asked him why the National Science Foundation had turned to the development of instructional materials in science and mathematics to implement the National Defense Education Act. He replied that, in response to the mandate from Congress to strengthen the teaching of science and mathematics, the NSF decided that the quickest and most effective way to bring about a nationwide transformation was to develop instructional materials that included the new research combined with a teacher education program correlated with them.

Furthermore, when the editors, as part of their jobs, became acquainted with the curriculum projects as they were being developed, and when some of their authors (and potential authors) became deeply involved in many of them, the publishers began to realize the impact the programs would have on education. As they became better acquainted with the programs, it was clear that they would have to pay attention to them and, despite some continuing misgivings and reservations, they did. All thoughtful and responsible el-hi publishers, without exception, eventually began to view curriculum projects as essentially another kind of author -- gigantic and overwhelming in some instances, but an author nevertheless.

They all came to a position something like this: "We may not wholly approve of some of the procedures in developing materials, and we might develop them differently if we were responsible for them; nevertheless, if we think we are capable of publishing them successfully and profitably, there is no reason why we should not respond to the invitations to submit proposals to publish them."

As a rule, the invitations issued by the study groups included a conference where spokesmen for the study group would brief the publishers on the projects, explain the procedure for submitting proposals, and answer questions the publishers might raise. These invitations issued by the study groups were forwarded to all el-hi publishers and they were all given equal opportunity to submit proposals.

Virtually all the first-line publishers eventually responded to the invitations, and many of them were successful bidders. More than half of the companies listed on page three have published one or more curriculum projects developed by a curriculum center or study group, including those funded by the National Science Foundation.

By the early 1960's it also was becoming clear that one of the major aims of federally-funded curriculum research and development projects to stimulate the creation of competitive, commercially-funded innovative instructional materials, was beginning to be realized. At one publisher's meeting in those days, the McGraw-Hill representative said to the Harcourt representative: "We couldn't have published some of the things we're publishing now if you hadn't published A-LM (i.e., the USDE-funded "Glastonbury project" in modern foreign languages).

It was clear that other instructional materials developed by publishers were beginning to reflect many of the new approaches, and were selling better as a result.'

The development of instructional materials in mathematics by federal funds and private funds also indicates the influence of the curriculum studies in encouraging publishers to publish materials with the new approach.

As early as 1962 there were as many as sixteen algebra series reflecting in their titles a modern mathematics approach.

For the teaching of modern mathematics in the elementary schools, new textbooks were published in rapid succession, including those developed by commercial publishers, as well as others developed by study groups and curriculum centers. In fact, one of the most successful programs in winning adoptions was developed and published by a commercial publisher.

With instructional materials available to them for the teaching of modern math, modern science, and modern foreign languages, educators rapidly adopted the new curriculum materials. For example, within a short period of time after the new math was made available, it is estimated that 85 percent of the nation's schools had adopted the new math in some form or other.

Although recently-published curriculum materials combine some of the old math with the new, especially in computation, the new math has led to permanent changes in school curricula. And the new math received its major impetus from the mathematics curriculum development centers including the School Mathematics Study Group (SMSG) funded by the National Science Foundation

One of the doubts initially held by many el-hi publishers was that teachers would not have the capability of using effectively the new curriculum materials developed by curriculum centers without the benefit of special training. The fact that some of the projects, particularly the NSF projects and the "Glastonbury project" that led to A-LM, planned to provide this training in summer institutes and workshops, was a big "plus" factor in the minds of el-hi publishers, who simply could not provide the necessary teacher recycling with their own funds and the consultants on their staff.

In reviewing today the developments in the industry, el-hi publishers are likely to take a different point of view about federally-funded curriculum projects from the point of view they held less than two decades ago. For one thing, educational publishing continues to be very much alive, and even thriving. For another, the industry has transformed itself from publishers of textbooks to publishers of programs composed of many components. Today, publishers generally tend to be interested in publishing programs of excellence wherever they are developed. It can be said with some confidence, we believe, that any curriculum project that meets the demands of the educational marketplace is likely to find a publisher.

To this we add our personal opinion that the earlier a developer of a curriculum project can reach an agreement with a publisher, the better it will be for both parties and for the program.

The impact of the federally-funded curriculum projects perhaps can be best summer up in the words of a typical publisher, "They certainly have shaken up the industry and education and made us think."

The most convincing evidence, however, that these curriculum projects have been good for publishing is, of course, the long list of commercially-published programs now available that grew out of them, including the early projects developed by PSCS and BSCS.

Although the list of innovative instructional materials programs funded by the National Science Foundation and other governmental and non-governmental agencies currently in use in the schools is impressive, perhaps the larger contribution the programs have madetto the improvement of education is their impact on the development of instructional materials by commercial publishers. For example, in the description of a well-known elementary science program. the publisher makes this comment: "This program takes advantage of the research and teacher experience gained from the federally-financed science curriculum development projects of the 1960's." Another publisher gives credit to federally-funded science projects with this comment: "Investigations in Science is a grade 1-6 textbook series published in 1972 which incorporates major features of several of the federally-financed science curriculum development projects."

Although the instructional materials developed by curriculum study centers and by commercial publishers are influenced by the same trends in education and American society, the commercial publisher has had the opportunity to benefit from the emphasis the curriculum programs have given to the improvement of education in many areas, including these:

1. In cognitive learning, especially in identifying and developing concepts.
2. In the use of inquiry and discovery in learning.
3. In the preparation of a series based on sequential and cumulative learning, especially in social studies.
4. In the use of diversified materials for which curriculum study programs may have served as models.
5. In developing individualized programs for the teaching of math and reading and other subjects.
6. In the development of materials that involve the student in the thought processes of the specialists in the discipline.
7. In the preparation of bilingual programs of insturction.

8. In closing the gap between the current research in a discipline and the content of the instructional materials used in the classroom.

9. In using field-testing as a technique for improvement.

To summarize, the federally-funded research and development that was launched in 1958 with many misgivings on the part of many educational publishers has now become an integral part of the el-hi publishing process.

Appendix 7

Curriculum Development Financial Arrangements

Curriculum Project	Grantee	Develop-ment	Implemen-tation	Publisher	Date of Publishing Agree-ment	Royalty Rate	Exclusive Period	Comments
PSSC	EDC (MIT) G-13087 G-3100, G-13912 G-18846, G-18854 G-21793, G-22130 GE-2568, GE-1995 GE-3846, GE-4496	$5.3M	$6.8M	D.C. Heath Company	1959	12%	No limit	International Edition Published by D.C. Heath 4/17/67, 12% royalty till 12/31/70, 9% thereafter
SMSG	Stanford (Yale) G-18758 G-5422, G-6306 G-16904, G-17624	$14.4M	$2.26M	None	—	—	—	Random House (Singer) had an exclusive distribution arrangement ($.05/copy). Yale University Press sold trial editions at cost
CBA	Earlham College (Wesleyan & Reed) G-11217 G-6493, G-5456 G-9158	$1.2M	$2.3M	McGraw-Hill (Webster Div.)	1962	10-12%	No limit	a sliding royalty scale of 10% for 50,000 copies and 12% thereafter
BSCS	U. of Colorado (AIBS) G-7220 GE-1321	$10.4M	$9.4M	Houghton Mifflin (Blue) Rand McNally (Green) Harcourt Brace (Yellow)	1964 1963 1963	20% 20% 20%	No limit	2nd Edition—8% royalty Free use after 6/30/73
CHEM Study	U. California—Berkeley (Ohio St.) G-12226 G-11090, G-7656	$2.6M	$4.6M	None	—	—	—	W.H. Freeman distributed hard cover version. Revisions published by D.C. Heath Houghton-Mifflin & Prentice Hall at no royalties but for $35 K each.
Elementary School Science Project	U. of California—Berkeley G-13879 G-9153, G-18845	$.7M	$6K	None	—	—	—	No commercial publisher—materials sold at cost
Elementary School Science Project (ESSP)	U. of Illinois G-13906	$.6M	$6K	Harper & Row	1968	6%	8 years	6 books
TV Program for Mathematics Teachers	Minnesota Academy of Sciences G-13885	$.2M	$0	—	—	—	—	
Syracuse Webster Mathematics Project (Madison Math)	Webster College G-19148	$1.1M	$2.5M	—	—	—	—	Houghton Mifflin distributed films (11/71) at a sliding royalty rate of ½%-2% depending on footage. Free use after 12/31/79.
Elementary Science Study (ESS)	EDC G-21815	$7.6M	$4.1M	McGraw-Hill (Webster Div.)	1969	7%	4½ years	Publisher not obligated to pay royalty after free use
Anthropology Curriculum Study Project (ACSP)	American Anthropological Association G-22323	$1.4M	$.7M	The MacMillan Company	1966	12½%	None	Royalty rate was reduced 50% if sales were less than 500 copies the first year

Curriculum Project	Grantee	Development	Implementation	Publisher	Date of Publishing Agreement	Royalty Rate	Exclusive Period	Comments
Science—A Process Approach (SAPA)	AAAS G-22286	$2.3M	$4.9M	Xerox (Ginn)	1967	6%	7½ years	Royalty based on gross receipts. Revision also published with sliding scale (½%-3%)
Univ. of Illinois Commitee on School Mathematics (UICSM)	U. Illinois G-23554	$4.9M	$5.8M	The MacMillan Co.—Vector Geometry Harper & Row 7th & 8th Grades	1968 1968	8% 3%	6 years 7½ years	 Rate justified by difficulty in selling material
MINNE-MAST	U. of Minn. GE-3	$5.0M	$.7M	W.B. Saunders	1969	15-17%	4½ years	Sliding scale: 15% (10K copies), 16% (10-20K) and 17% (>20K). Edu. Tech. also given 5 years exclusive for distribution of some material (7/27/73) for $3000.
Science Curriculum Improvement Study (SCIS)	U. of California—GE-2914 (U. Maryland) GE-600	$4.3M	$6.7M	Rand McNally	1970	4-6%	2 years	D.C. Heath was the initial publisher at a 5% rate. Rand McNally's rates were 6% for the guides and 4% (up to 200,000 copies of the student manual) and 6% thereafter.
Earth Science Curriculum Project (ESCP)	American Geological Institute GE-1426	$3.5M	$.7M	Houghton Mifflin	1967	8%	5½ years	Films also distributed
School Science Curriculum Project	U. of Ill. GE-1816	$.97M	0	—	—	—	—	No commercial distribution
MACOS	EDC GE-3430 GE-1831, GE-2567	$4.8M	$2.2M	CDA	1970	3%	5½ years	Film royalties included rates of 2½%, 5%, 15% and 20%.
Elementary School Science Improvement Project	Utah State GE-1376	$.1M	0	—	—	—	—	No commercial distribution
Secondary School Science Project	Rugters GW-2272 (Princeton) GE-2272	$1.2M	$.65M	McGraw-Hill (Webster)	1966	8%	No limit	Princeton & Rutgers split royalties on a 75%-25% basis
Introductory Physical Science (IPS & PSII)	EDC GE-2510	$1.4M	$5.0M	Prentice Hall	1965	10%	No limit	Publisher distributed preliminary text in paperback
Films for In-Service Education of Teachers of Elementary School Mathematics	National Council of Teachers of Mathematics GE-2651	$.28M	0	—	—	—	—	United World Films, Inc. distributed films on a 5-year exclusive basis for a 12½% royalty on gross rentals

Curriculum Project	Grantee	Development	Implementation	Publisher	Date of Publishing Agreement	Royalty Rate	Exclusive Period	Comments
Quantitative Approach in Elementary School Science	SUNY at Stony Brook GE-2651	$21K	$11K	—	—	—	—	No commercial distribution
High School Course Modern Coordinate Geometry	Wesleyan U. GE-4319	$137K	0	Houghton Mifflin	1969	5%	8 years	
High School Geography Project (HSGP)	Association of American Geographers GE-5168	$2.3M	$1.9M	The MacMillan Company	1968	8%	6 years	MacMillan in 1970 acquired exclusive rights for 7 years to publish reference volumes at a 3% royalty (for first 15K copies) and 8% thereafter
Sociological Resources for the Social Studies (SRSS)	American Sociological Association GE-5186	$2.5M	$1.8M	Allyn & Bacon, Inc.	1968	8%	6 years	Royalty on gross proceeds
Engineering Concepts Curriculum Project (ECCP)	SUNY of Stony Brook GW-7646 (Commission on Engineering Edu. Polytechnic Inst. of Brooklyn) GE-5973, GW-2247	$2.0M	$3.0M	McGraw-Hill (Webster Div.)	1971	8%	7 years	
Elementary Mathematics Project	EDC GE-7813	$1.6M	$120K		—	—	—	Agreement under negotiation
Harvard Project Physics (PPC) Course	Harvard U. MOR 65-45 AG-161, MOR 69-13	$0.9M	$4.7M	Holt, Rinehart & Winston, Inc.	—	—	—	Supported by OE. NSF funding provided by interagency transfer
Second Course in Physical Science (PS II)	Newton College of the Sacred Heart (EDC) GW-2187 GW-6719	(See IPS-EDC)		Prentice Hall	1970	10%	5 years	Original publishing agreement of 6/70 between EDC & Prentice-Hall assigned to Newton on 12/70
Portland Interdisciplinary Science Project	Portland State University GW-4216	$144K	$3K	—	—	—	—	
ISCS	Fla. State GW-4235	$1.5M	$5.0M	General Learning Corp. (Silver Burdett)	1972	10-15%	5 years	Phase I materials supported by OE under separate contract. Same publisher and similar royalty rates. Sliding scale at 10% for first 5000 modules and 15% thereafter.

Curriculum Project	Grantee	Develop-ment	Implemen-tation	Publisher	Date of Publishing Agreement	Royalty Rate	Exclusive Period	Comments
Secondary School Mathematics Curriculum Improvement Study (SSMCIS)	Teacher's College Columbia GW-4533	$.7M	$.19M	Columbia Teacher's College Press	1974	10-12%	10 years	10% rate for Courses 4 & 5 12% rate for Course 6
Computer-Based Self Instructional Course for Supplementary Training of Secondary School Teachers of Physics	U. of Cal. (Berkeley) GW-5061	$139K	0	—	—	—	—	Evaluation study of adequate mode of instruction for teachers newly introduced to Harvard Project Physics. Materials need further improvement before publication possible
Environmental Studies for Urban Youth (ES)	Evergreen State College (AGI GW-5387) GW-[illegible]900	$.9M	$.8M	Addison Wesley	—	—	—	Agreement Under negotiation
Comparing Political Experiences (CPE)	American Political Science Association GW-6810	$1.3M	$57K	—	—	—	—	Course under development. Some materials available for trial use.
Improvement Project in Mathematics for Subcultural Groups	S.W. Education Development Lab. GW-3424	$.4M	—	—	—	—	—	Materials not available for commercial distribution
Biomedical Interdisciplinary Curriculum Project (BICP)	California Committte on Regional Medical Program GW-6815 (U. Cal.-Davis GW-6801) U. Cal-Berkeley GW-3435	$1.85M	$.16M	—	—	—	—	Materials not available for commerical distribution
Demonstration and Experimentation in Computer Training and Use in Secondary Schools	Dartmouth College GW-2246	$.33M	—	Prentice Hall	1971	15%	6 years	10% rate on foreign sales

Curriculum Project	Grantee	Development	Implementation	Publisher	Date of Publishing Agreement	Royalty Rate	Exclusive Period	Comments
Boston University Mathematics Program	B.U. GW-7912 (PES 74-18105—	$294K	—	—	—	—	—	Agreement under negotiation
Development of Computer Simulation Material (Huntington II)	SUNY-Stony Brook GW-7647 (Polytechnic Inst. of Brooklyn GW-5883)	$.47M	$.15M	Digital Equipment Corporation	1974	20%	7 years	Royalty rate applies only to period of exclusivity. Copyright later assigned to SUNY
Development of Teacher Training Materials in Mathematics	State College of Iowa G-24992	$24K	—	—	—	—	—	Study guides sold at cost by grantee
Experimental Teaching of Mathematics in Elementary School	Stanford G-9173 G-18709	$2.7M	—	Academic Press	1971	10-15%	10 years	No royalties on first 2000 copies, 10% on second 2000 12% on third and 15% thereafter
Exploring Human Nature (EHN)	EDC GW-5209	$2.5M	$.15M	CDA	—	—	—	Agreement under negotiation. Trial editions sold at cost
First Year Algebra with Applications Project	Chicago GW-7915	$36K	—	—	—	—	—	Materials not available
Human Behavior Curriculum Project	APA GW-7905	$.7M	—	—	—	—	—	Materials under preparation
Human Sciences Program	BSCS GW-7644 (U. Colorado) GW-6700	$1.3M	$.5M	—	—	—	—	In testing phase
Individualized Science Instructional System (ISIS)	Florida State GW-7645	$3.4M	$.16M	Xerox (Ginn)	1974	8-13%	10 years	8% (0-$15 million sales) 10% ($15-30 million) 13% (over $30 million)
Mathematics Problem Solving Project	Indiana GW-7911	$265K	—	—	—	—	—	Materials under preparation
Mathematical Resources Project	Oregon GW-7810 GW-7910	$292K	—	—	—	—	—	Dissemination of materials by grantee in cooperation with Oregon Mathematics Education Council

Curriculum Project	Grantee	Develop-ment	Implemen-tation	Publisher	Date of Publishing Agreement	Royalty Rate	Exclusive Period	Comments
Outdoor Biology Instructional Strategies (OBIS)	U. of Cal. Berkeley GW-6820 (PES 74-2091	$.67M	$.3M	—	—	—	—	Trial materials sold at cost Commercial distribution plan not formulated yet
Project for the Mathematical Development of Children	Florida State GW-7913 (PES 74-18106)	$.47M	$2K	—	—	—	—	Materials under development
Technology-People-Environment (TPE)	SUNY at Stony Brook PES 73-06358	$134K	$163K	Learning Realities Inc.	—	—	—	Agreement under negotiation
Unified Science and Mathematics for Elementary Schools (USMES)	EDC GW-5207	$2.6M	$1.3M	—	—	—	—	Publisher is being selected Houghton-Mifflin is publishing USMES Conference Project

SUMMARY

Royalty Rates (3-20%)

Exclusive Periods vary from unlimited—to 2-10 years, restrictions seem to come into existence in 1967.

Foreign royalties are generally at 50% of the domestic rates.

Royalty Rates

3%	(2)
4%	(1)
5%	(1)
6%	(2)
7%	(1)
8%	(7)
10%	(6)
12%	(2)
15%	(2)
20%	(4)